BOONTON

Instruction Manual

Model 92B

STABRO LABORATORIES

Millivoltmeter

Instruction Manual

Model 92B

STABRO LABORATORIES

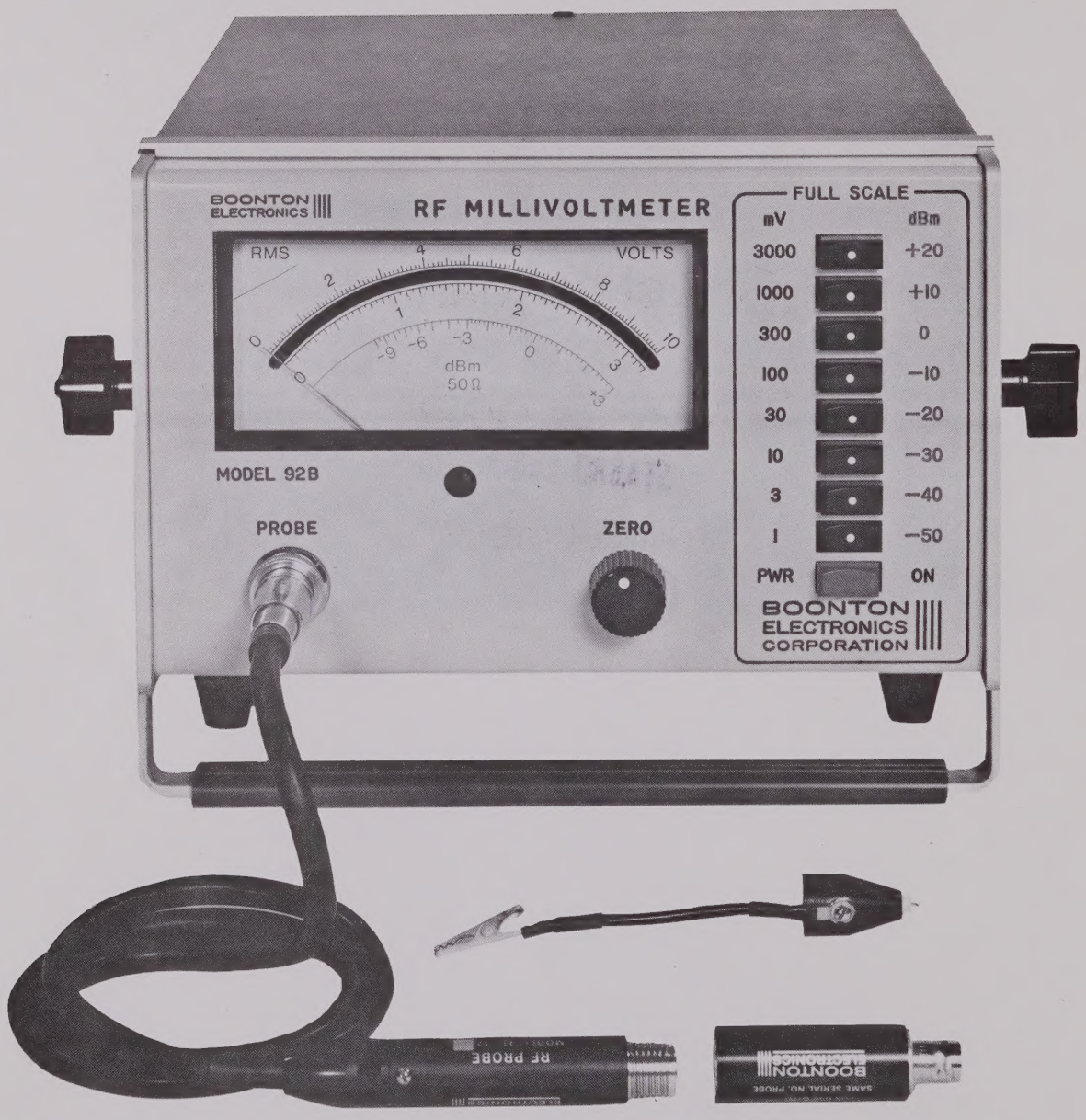
Millivoltmeter

92B
1173

BOONTON ELECTRONICS CORPORATION

TEL: 201-887-5110
TWX: 710-986-8241

ROUTE 287 AT SMITH ROAD
PARSIPPANY, N.J. 07054 USA



MODEL 92B RF MILLIVOLTMETER

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
	1.1 GENERAL	1
	1.2 EQUIPMENT DESCRIPTION	2
	1.2.1 Frequency Capability	2
	1.2.2 Voltage Capability	2
	1.2.3 True RMS Response	2
	1.2.4 Low Noise	3
	1.2.5 Minimal Zero Adjustment	3
	1.2.6 DC Output	3
II.	SPECIFICATIONS	3
III.	OPERATION	9
	3.1 INSTALLATION	9
	3.1.1 Operating Controls and Indicators	9
	3.2 OPERATING PROCEDURES	10
	3.2.1 Initial Operating Procedure	10
	3.3 OPERATING NOTES	10
	3.3.1 Overload Limits	10
	3.3.2 Connection for Measurements Below 100 MHz	10
	3.3.3 Connection for Measurements Above 100 MHz	10
	3.3.4 Low - Level Measurement	12
	3.3.5 Making the Zero Adjustment	12
	3.3.6 Signal Overload on 1 mV Range	12
	3.3.7 Temperature Effects	12
	3.3.8 Hum, Noise, and Spurious Pick-up	12
	3.4 DC OUTPUT	12
	3.5 LOW FREQUENCY MEASUREMENTS	13
	3.6 CORRECTION CURVES FOR ACTUAL VOLTAGE vs METER READING	13
	3.7 LOSS vs FREQUENCY CORRECTION FOR MODEL 91-8B	13
	3.8 LOSS vs FREQUENCY CORRECTION FOR MODEL 91-14A	13
IV.	THEORY OF OPERATION	16
	4.1 GENERAL	16
	4.1.1 RF Probe	16
	4.1.2 Attenuator and Amplifiers	16
	4.1.3 Synchronous Detector	17

Chapter | Page

4.1.4 Shaping Amplifier 17
4.1.5 Chopper-Driver Circuits 17
4.1.6 Power Supply 17
4.1.7 Programming 17

V. MAINTENANCE

5.1 PERIODIC CALIBRATION 18

5.2 PRECAUTIONS WHEN CHECKING CALIBRATION 18

5.3 CALIBRATION CHECK 18

5.4 CALIBRATION PROCEDURE 18

5.5 TROUBLE - SHOOTING PROCEDURE 20

5.5.1 Cover Removal 20
5.5.2 Chopper Replacement 20
5.5.3 Voltage and Resistance Tests 20
5.5.4 Test Points 20
5.5.5 Replacement of RF Probes 20
5.5.6 Probe Tests 21

VI. INTERFACE 22

6.1 INPUT CHARACTERISTICS 22

6.2 INPUT PULL - UP 22

6.3 ANALOG OUTPUT 22

VII. TABLE OF REPLACEABLE PARTS 24

VIII. SCHEMATIC DRAWINGS Endfold

ILLUSTRATIONS

CHARTS AND DRAWINGS

Figure		Page
1	Input Resistance of RF Probe as a Function of Input Level and Frequency	7
2	Input Capacitance vs Input Level of Model 91-12F Probe (Measured at 10MHz)	8
3	Typical VSWR of Model 91-12F RF Probe with Model 91-8B 50 Ω BNC Adapter	8
4	Typical VSWR of Model 91-12F RF Probe with Model 91-14A Type N Tee Adapter and Model 91-15A 50Ω Termination	8
5	Assembly of Model 91-14A Type N Tee Adapter	11
6	Correction Curves, Actual Voltage vs Meter Reading	14
7A	Model 91-8B 50Ω BNC Adapter Correction Curve	15
7B	Model 91-14A Type N Tee Adapter Correction Curve	15
8	Block Diagram	16
9	Calibration Instructions	19
10	Pin Designations	22
11	External Connections	23
	VSWR Test Block Diagram	21a
	RF Probe Response Block Diagram	21a

TABLES

Table		Page
1	Required Accessories	6
2	Crest Factors	6
3	Model 92B Controls and Indicators	9
4	Connection Recommendations	11

CHAPTER I

INTRODUCTION

1.1 GENERAL

The Model 92 Series RF Millivoltmeter provides an accurate readout of measurements from the low radio frequencies to the gigahertz region, over a voltage range of 200 μV to 3 volts. It is a programmable, solid-state instrument of high sensitivity and accuracy, characterized by high input impedance (see Figs 1 and 2), excellent stability, and low noise.

The Model 92 exhibits true rms response for input signals up to 30 millivolts, gradually approaching peak-to-peak above this level. The meter, however, is calibrated to indicate rms of a sine wave above 30mV.

Input and output connections for external control and readout are provided by a 22-pin card-edge connector at the rear of the instrument.

A linear dc output, whose level is proportional to the rf input voltage, is also provided at a rear connector. This may be used to drive a recorder, remote indicator or other analog devices.

The 92 offers a convenient and accurate means for making a wide variety of measurements. Typical uses of this instrument include:

In transistor testing the instrument may be used to measure β, f_t, and other transistor parameters.

VSWR and return loss measurement using the Model 92 Series with bridge methods, directional couplers, and adjustable or slotted lines.

Gain and loss measurements in wide-band amplifiers, including such design characteristics as stage gain, flatness of the pass band, upper cut-off or corner frequency, negative feedback factors, and other parameters.

Proper adjustment of tuned circuits in narrow-band amplifiers.
The adjustment, measurement of performance, and evaluation of rf filter parameters.

Measurement of vswr or return loss and attenuation of rf attenuators.

Measurement of output levels of signal generators, adjustment of baluns, harmonic distortion of rf signals, and adjustment of circuits for minimum voltage (null) or maximum voltage (peak).

The Model 92 is available in several optional configurations with a basic accuracy of 1% rdg. + 1% fs. The standard features of the instrument are:

Remote programmability.

Measures from 200 μV to 3V* from 10 kHz to 1.2 GHz.

True rms response to 30 mV**

Convenient push-button ranging.

DC analog output.

High input resistance, low input capacitance.

Overload protection to 400 Vdc and 10 Vac.

VSWR less than 1.2 up to 1.2 GHz.

*To 300 V, up to 700 MHz, with accessory 100:1 divider.

**To 3V, up to 700 MHz, with accessory 100:1 divider.

The characteristics of the instrument include: high reliability, fast warm-up (1 minute typical), long intervals between calibrations, plug-in PC boards for ease in servicing or modifying, lightweight, and other advantages of solid state design.

1.2 EQUIPMENT DESCRIPTION

The Model 92 is basically a programmable analog instrument with linear dc output. It is available with a full range of options and accessories as described in Chapter II. Logic level programming, TTL/DTL compatible, is standard.

The instrument is sensitive, accurate, sturdily constructed, and protected against overloads. It will perform over extended periods of time without failure or need for recalibration. It is packaged as a compact bench instrument that can be easily mounted in a standard 19-inch rack using an optional rack-mounting kit.

Important input and accuracy specifications are reproduced on a reference plate fastened to the exterior top cover of the instrument. Clips for holding out-of-use accessories are provided at the rear of the instrument. Calibration instructions are reproduced on the underside of the top cover of the instrument.

Standard accessories supplied with the Model 92 Series include one each of the following:

Model 91-12F RF Probe with low-noise cable and connector.

Model 91-8B 50-ohm BNC adapter.

Model 91-13B Probe Tip (removable) with grounding clip lead.

A complete kit of probe accessories is available as optional equipment, including a storage case with space for the Model 91-12F RF Probe and the other standard accessories.

1.2.1 Frequency Capability

The calibrated frequency range of the Model 92 extends from 10 kHz to 1.2 GHz, with uncalibrated response to beyond 8 GHz. Relative accuracy above 1.2 GHz is typically ± 0.5 dB.

A Model 91-8B 50-ohm BNC Adapter is supplied as a standard accessory with the instrument for 50-ohm voltage measurements up to 600 MHz. A correction curve (Figure 7A) is included for frequencies above 50 MHz. For higher-frequency measurements and for through-line voltage measurements the optional accessory, Model 91-14A Tee Adapter, is recommended. It is designed to compensate for the rf probe capacitance and to present a good vswr (better than 1.15) up to 1.2 GHz. It may be used in conjunction with the Model 91-15A 50-ohm load for terminated voltage measurements. In a coaxial line its insertion loss is low; however, a chart (Figure 7B) is supplied showing loss vs. frequency. See Figure 4 for typical vswr.

An optional accessory, the Model 91-4C RF Probe, has a frequency range of 1 kHz to 250 MHz for lower frequency applications.

1.2.2 Voltage Capability

The Model 92 has eight ranges, from 1 millivolt full scale to 3 volts full scale, arranged in 1-3-10 sequence. No attenuator attachments are required for measurements up to 3 volts. While this range is ample for most rf voltage measurements, the capability of the instrument can be increased to 300 volts (up to 700 MHz) by using the optional accessory, Model 91-7C 100:1 Voltage Divider. Use of the 100:1 Voltage Divider also increases the input resistance of the Model 91-4C RF Probe by a factor greater than 100.

1.2.3 True RMS Response

The Model 92 provides true rms response for signal inputs below approximately 30 millivolts (below 3 volts, up to 700 MHz, with the Model 91-7C 100:1 Voltage Divider). As the input level increases, the waveform response gradually approaches peak-to-peak, calibrated on the indicator in rms. Thus, in addition to making precise sinusoidal voltage measurements at all levels, the instrument measures non-sinusoidal or asymmetrical signals within the rms region without loss of accuracy.

1.2.4 Low Noise

The Model 92 has been designed and constructed to hold noise from all sources to a minimum.

The probe cable is of special low-noise design; a vigorous flexing causes only momentary, minor deflections on the most sensitive range. The Model 91-12F Probe is not sensitive to shock or vibration; even sharp tapping on the probe barrel causes no visible deflection on any range.

Amplification takes place at 94 Hz, reducing susceptibility to any 50 or 60 Hz line-frequency-related fields. A unique circuit reduces the low-level noise originating from the mechanical chopper and renders the instrument immune to changes in chopper performance that could occur with the passage of time.

1.2.5 Minimal Zero Adjustment

Zero adjustment is not required on the upper five sensitivity ranges of the Model 92. For measurements on the lower three ranges, the ZERO control is set on the most sensitive range before operation. This control balances out small thermal voltages in the probe elements and, once adjusted, requires only infrequent checking during the course of subsequent measurements.

1.2.6 DC Output

The 92 provides a linear dc output whose current capability of 1 mA into 1000 ohms is extremely stable. When used as part of an automatic test system, the fast response of the instrument's dc output to an input step function allows more tests per unit time.

For system or external requirements, all input and output connections for the 92 are made at the card-edge connector on the rear of the instrument. (See Figure 11 for receptacle connections.)

CHAPTER II

SPECIFICATIONS

Voltage Range: 100 µV to 3V (300V up to 700 MHz with accessory 100:1 voltage divider). Voltage sensitivity is 100 µV.

Full Scale Voltage Range: 1, 3, 10, 30, 100, 300, 1000, and 3000 mV.

dBm Range: -60 to +23 dBm (+63 dBm up to 700 MHz with optional accessory, Model 91-7C 100:1 Voltage Divider).

Frequency Range: 10 kHz to 1.2 GHz (uncalibrated response to approximately 8 GHz).

Accuracy:

	1% fs plus			
300mV to 3V	1% rdg	1% rdg	3% rdg	10% rdg
100µV to 300mV*	2% rdg			7% rdg
	10 kHz	50 kHz	150 MHz	700 MHz	1.2 GHz

*Below 1 mV, add 1% fs

Meter: 4-1/2 inch taut-band

Two linear voltage scales

0 to 3; 0.05 per division

0 to 10; 0.1 per division

One logarithmic dBm scale

-10 to +3; 0.2 per division max.

728
1173

Meter Unrest: (1 mV fs range only)

Indicated Voltage	Unrest
Above 600 μV	< 1% fs
300 μV to 600 μV	< 2% fs
100 μV to 300 μV	< 5% fs

Power: 115 or 230 V ±10%, 50 to 400 Hz.

RFI: There is no detectable radiated or conducted leakage from instrument or probe.

Temperature: In accordance with ANSI (ASA) Spec. 39.7.

Temperature Range	Temperature Instrument	Influence RF Probe
Ref. 21° to 25° C	0	0
Normal, 18° C to 30° C	0	±1% rdg
Severe, 10° C to 40° C	±1% rdg	±4% rdg

Waveform Response: True rms response for input levels up to 30 mV (3V to 700 MHz with 100:1 Voltage Divider), with transition to peak-to-peak (calibrated in rms) at higher levels.

Crest Factor: 420 to 1.4 depending upon input level (see Table II).

Input Impedance: See Figures 1 and 2.

VSWR: Less than 1.20 to 1.2 GHz (Return Loss greater than 23 dB). See Figures 3 and 4.

Power Sensitivity: 200 pW, minimum detectable power in 50 ohms.

DC Output: 0 to 10 V dc proportional to rf input voltage. Source resistance of 9 kΩ; will deliver 1 mA into 1 kΩ load. Full scale input step function response time less than 100 ms on 30 mV fs to 3V fs ranges, increasing to 1 sec. on the 1 mV fs range.

Dimensions: 5.2" H (without rubber feet), 8.3" W (1.2 of standard 19 inch rack module) 11.5" D (132 x 211 x 292 mm).

Weight: Net 7 lbs. (3.2 kg)

Accessories Furnished:

Model 91-12F, RF Probe. RF Probe with low-noise cable and connector assembly for measurements from 10 kHz to 1.2 GHz; see Figures 1 and 2 for input resistance and capacitance.

Model 91-13B, Probe Tip. Removable Probe Tip with grounding clip lead; for use up to approximately 100 MHz.

Model 91-8B, 50Ω BNC Adapter. Used for measurements up to 600 MHz with a 50-ohm system; for VSWR see curve of Figure 3.

Warm-Up: Warm-up period, typically 1 min. Adjust zero on 1 mV range when measuring below 30 mV.

Accessory Kit (Optional) Model 91-24A:

Model 91-6C, Unterminated BNC Adapter. Used for coaxial connection up to approximately 100 MHz, or to 400 MHz when fed from a 50-ohm source in an electrically short system.

Model 91-7C, 100:1 Voltage Divider. Attenuates input signal by a factor of 100 (±1%), permitting measurements up to 300 volts and extending the rms measuring range to 3 volts; increases input resistance by a factor of 1000; operates from 50 kHz to 700 MHz. Maximum input potential, 1000 volts, dc plus peak ac.

Model 91-14A, 50Ω Tee Adapter. Type N Tee Connector; with Model 91-15A termination (see below) permits connecting into 50-ohm line; required for measurements above approximately 100 MHz; for VSWR see curve of Figure 4.

Other Accessories (Optional) Available:

Model 91-15A, 50Ω Termination, Type N 50-ohm termination for use with Model 91-14A Tee Connector.

Model 91-18A, Storage Case. Case for protecting and storing Model 92B accessories.

Model 91-4C: Special 1 kHz to 250 MHz RF Probe. Low Frequency probe for measurements ranging from 1 kHz to 250 MHz; input resistance essentially the same as that of Model 91-12F, RF Probe.

Model 91-16A, Unterminated Type N Adapter. May be used with all probes, except Model 91-23A. Used for coaxial connection up to approximately 100 MHz, or to 400 MHz when fed from a 50-ohm source in an electrically short system.

Model 92-1A, Single Rack Mounting Kit. Kit for mounting one 92B as one-half of a module in a standard 19-inch rack.

Model 92-1B, Double Rack Mounting Kit. Kit for mounting two 92B's side-by-side in a standard 19-inch rack.

Standard Equipment Options:

Model 92B-03. dBV option, dB scale, referred to 1 volt.

Model 92B-04. dBV option, dB scale, referred to 1 volt, is read out on top scale on meter.

Model 92B-05. 75Ω dBm option; dBm scale, referred to 75Ω.

Model 92B-06. 75Ω dBm option; dBm scale, referred to 75Ω, read out on top scale on meter.

Model 92B-07. 50Ω dBm option; dBm scale, referred to 50Ω, read out on top scale on meter.

Model 92B-08. Rear signal-input option.

Model 92B-12. dBmV option, dB scale referred to 1 mV.

IMPORTANT NOTE:

Fully to exploit the capabilities of this instrument, the accessories listed below are required for the indicated ranges of operation.

Table 1. Required Accessories

MEASURING RANGE	REQUIRED ACCESSORY	REMARKS
100 MHz to 600 MHz	Model 91-8B 50Ω Adapter for shielded connection to 50-ohm line; other impedances available on request.	Supplied as standard equipment with the Model 92 Series
Above 600 MHz	Model 91-14A Tee Connector and 91-15A 50Ω Termination for connection into 50-ohm line.	Available separately
1 kHz to 250 kHz	Model 91-4C RF Probe	Available separately
Input levels up to 300 V; rms response with levels to 3V.	Model 91-7C 100:1 Voltage Divider; operates over frequency range from 50 kHz to 700 MHz	Available separately

For details on the availability of these and other Boonton Electronics Accessories for RF Voltmeters, call your local Boonton Electronics Sales Engineering Representative, or write directly to the factory at the address on the title page of this instruction book.

Table 2. Crest Factors

VOLTAGE RANGES (mV) AND CREST FACTORS								
VOLTAGE RANGES (mV)	1	3	10	30	100*	300*	1000*	3000*
CREST FACTOR**	420 to 42	70 to 14	21 to 4.2	7 to 1.4	420 to 42	70 to 14	21 to 4.2	7 to 1.4

*With accessory 100:1 Voltage Divider (see Table 1).
**Maximum permissible ratio of peak to rms value of voltage.

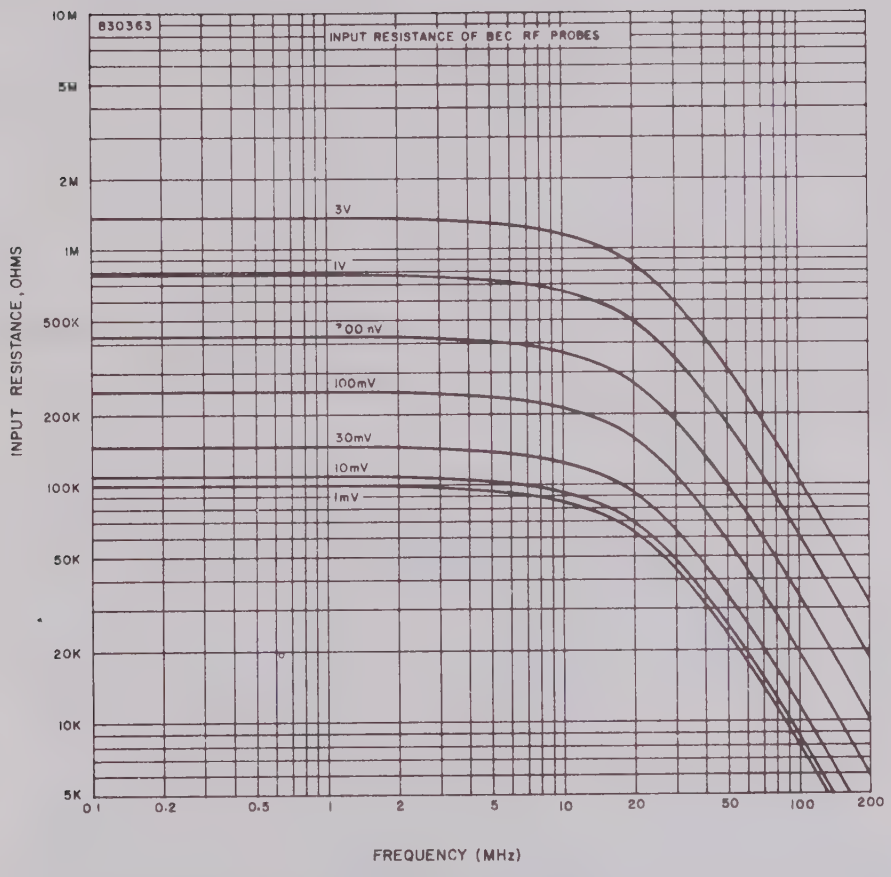


Figure 1. Input Resistance of RF Probe as a Function of Input Level and Frequency

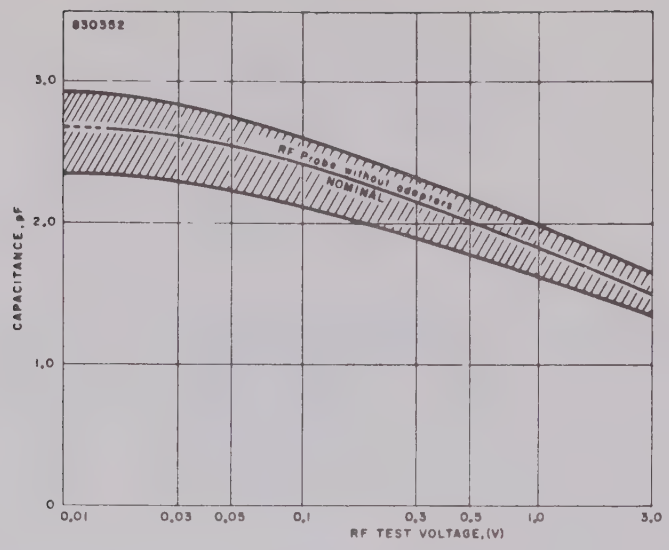


Figure 2. Input Capacitance vs Input Level of Model 91-12F Probe (Measured at 10MHz)

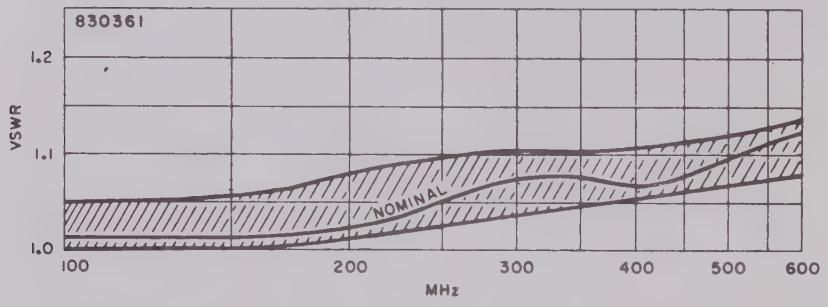


Figure 3. Typical VSWR of Model 91-12F RF Probe with Model 91-8B 50Ω BNC Adapter

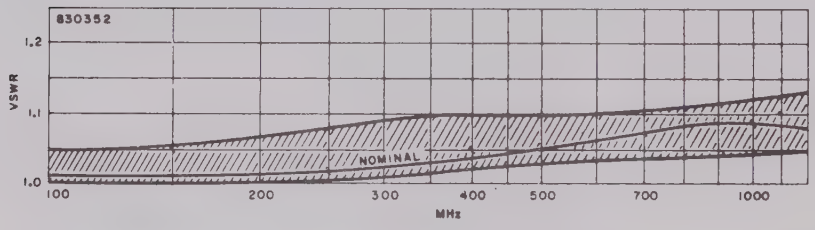


Figure 4.. Typical VSWR of Model 91-12F RF Probe with Model 91-14A Type N Tee Adapter and Model 91-15A 50Ω Termination

CHAPTER III

OPERATION

3.1 INSTALLATION

The Model 92B has been inspected and tested at the factory before packing, and is shipped ready for operation. If there is any indication of shipping damage, immediately notify the carrier before attempting to put the instrument into operation.

3.1.1 Operating Controls and Indicators

The controls and indicators installed on Model 92B are shown in Table 3.

Table 3. Model 92B Controls and Indicators

PWR ON	This switch turns on the instrument power.
FULL SCALE	These range pushbuttons, (1, 3, 10, 30, 100, 300, 1000, and 3000 mV) and (-50, -40, -30, -20, -10, 0, +10, and +20dB) select the operating range.
Meter	A 4-1/2 inch taut-band meter with two linear voltage scales reading out 0 to 3 with 0.05 per division and 0 - 10 with 0.1 per division; and one logarithmic dBm scale reading out -10 to +3 with 0.2 per division maximum.
PROBE (Jack)	The probe cable connects to the instrument through this PROBE jack. Always check that the knurled ferrule nut of the probe cable connection is tightened when in use.
ZERO (Control)	This control is used to zero the instrument.

The following items are on the rear panel:

Fuse Holder and Fuse	A fuse holder is located on the rear panel for installing either a 0.10 ampere, 115V, or a 0.06 ampere, 220 V, Bussman MDL SLO-BLO fuse.
Slide Switch	Switch which is set to 115 V or 230 V, according to the available power source. Be sure that the proper fuse is located in the fuse holder.
Recorder Output Terminals (Rear Panel)	A DC voltage proportional to the indicator reading is available at these terminals. F.S. output = +10V Output resistance = 9 kΩ
Component Holders (Clips)	Three component holders or component clips are located at the rear panel for securing accessories which are not in use.
REMOTE CONNECTIONS (Use with an Amphenol 225-22221-103 connector or equivalent)	A card edge connector is mounted at the rear of the instrument. See Figure 10 for the pin designations.
(Symbol on Rear Panel)	This safety requirement symbol has been adopted by the International Electrotechnical Commission, Document 66 (Central Office) 3, paragraph 5.3 which directs that an instrument be so labeled, if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source.

Verify that the right fuse is installed for the power available and that the switch on the rear panel 0.10A and 0.06A, 50-400Hz, is set to the applicable operating voltage of 115V or 230V. Within a brief time, the use of this symbol will be acted upon by ANSI (ASA).

3.2 OPERATING PROCEDURES

In the following paragraphs, the initial operating procedure for the 92B is described, as well as operating notes and recommended connection methods.

3.2.1 Initial Operating Procedure

a. Be sure that the serial number of the probe to be used is the same as that of the Model 92B. (Each instrument is calibrated for its particular rf probe.) Use of a probe other than that for which the instrument was calibrated may result in measurement errors.

b. Connect the probe cable to the PROBE jack on the front panel.

c. Check the setting of the power switch on the rear panel to be sure that it is set to the proper position for the line voltage available.

d. Plug the instrument's power cable into a power receptacle. Push PWR ON switch button.

e. Press the 1 mV range button; the panel meter pointer should rest on zero. If it does not, use the ZERO control to set the meter to zero. (This adjustment will hold for the other ranges.) The instrument is now ready for use. (See 3.3.5)

3.3 OPERATING NOTES

While using the Model 92B is a direct and straightforward process, there are certain precautions and procedures which MUST be observed to obtain satisfactory results.

3.3.1 Overload Limits

The Model 91-12F RF Probe supplied with the Model 92B is overload-protected to 10 volts, ac, and to 400 volts, dc. EXCEEDING THESE LIMITS MAY RESULT IN PERMANENT DAMAGE TO THE PROBE.

The Model 91-8B 50-ohm Adapter should not be subjected to continuous overload of more than 10 volts (dc + rms ac) to avoid excessive heating of the terminating resistor.

Where voltages above these limits are likely to be encountered, the Model 91-7C 100:1 Voltage Divider is required. Maximum rating of the Voltage Divider is 1000 volts, dc + peak ac.

3.3.2 Connection for Measurements Below 100 MHz

The RF Probe supplied with the Model 92B is equipped with a detachable tip and ground lead. For measurements of signals below approximately 100 MHz, this tip provides a convenient means for both signal and ground connection.

3.3.3 Connection for Measurements Above 100 MHz

For frequencies above 100 MHz, the probe tip should NOT be used with the Model 92B. Connection should be made directly to the center contact of the probe with the ground connection kept as short as possible

The connection recommendations outlined in Table 4 should be followed to maintain specified accuracy.

Table 4. Connection Recommendations

FREQUENCY	SIGNAL CONNECTION
Up to 100 MHz	Probe with tip and grounding lead, or with Model 91-8B (supplied) Probe with Model 91-14A/15A (optional)
100 to 250 MHz	Probe without tip (see Fig. 5), or probe with Model 91-8B (supplied) Probe with Modal 91-14A/15A (optional)
250 to 600 MHz	Probe with Model 91-8B (supplied) Probe with Model 91-14A/15A (optional)
600 MHz to 1.2 GHz	Probe with Model 91-14A/15A (See Figure 5) (optional)

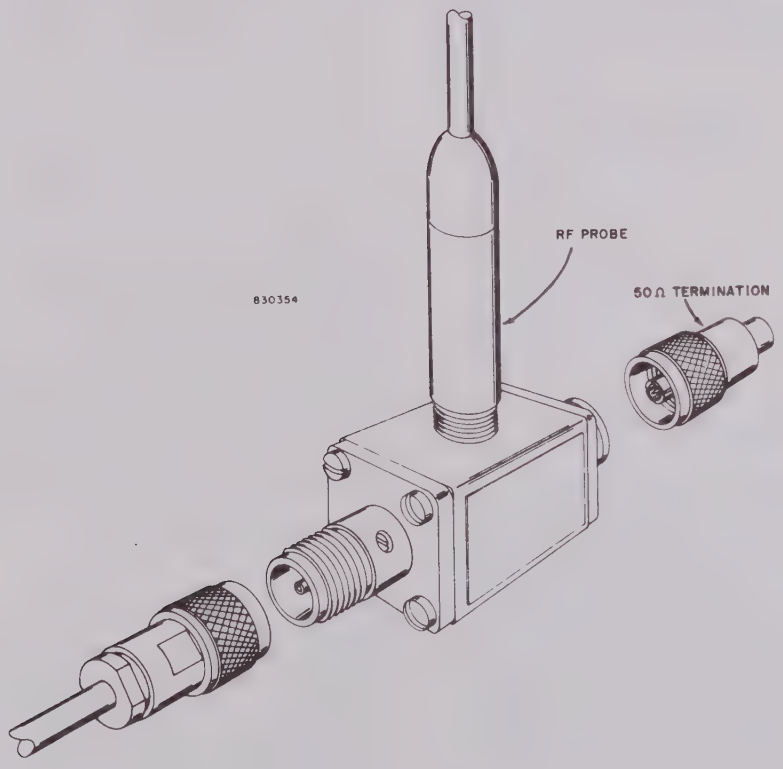


Figure 5. Assembly of Model 91-14A Type N Tee Adapter

3.3.4 Low-Level Measurement

The Model 92B will provide reliable, reproducible measurements of signal levels as low as 100 microvolts.

Preliminary zero adjustment is essential when using the lowest range scale to achieve the specified accuracy, and is strongly recommended for all ranges up to 30 millivolts.

3.3.5 Making the Zero Adjustment

When the instrument is to be used on the 1 mV range, the following zero adjustment procedure should be followed:

a. Set the FULL SCALE range selector to the 1 mV position.

b. Be sure that no voltage is applied to the probe, and that it is adequately shielded from local fields. This can be done by partially unscrewing the probe cap until the tip just breaks contact with the internal connector, leaving the metal shell engaged with the body threads. Alternately, the probe tip can be removed and the 50-ohm termination (Model 91-88) mounted in its place.

c. Adjust the ZERO control to bring the meter reading to zero. Noise will cause the reading to fluctuate up to ± 5% of full scale. Adjust the ZERO control so that the reading averages zero.

3.3.6 Signal Overload on 1 mV Range

On the most sensitive (1 mV) range, application of a large ac signal overloads the amplifier and a short time is required for the high-impedance input circuit to discharge. This effect is significant for signals above approximately 100 millivolts. Typically, application of a 1 volt signal will require a recovery time of about thirty seconds before subsequent measurements should be made. It should be noted, however, that such overloads cause no damage to the equipment as long as they are within the limits outlined in paragraph 3.3.1.

3.3.7 Temperature Effects

The accuracy specifications for the Model 92B apply over temperatures from 50°F to 104°F. Outside of these limits operation of the equipment is possible but appreciable inaccuracies can be expected. However, no permament change in probe characteristics will result from any reasonable high or low temperature exposure.

It should be noted that inaccuracies of measurement resulting from temperature effects may occur shortly after soldering to the probe tip, or measuring with the probe in the vicinity of heat sources such as resistors, heat sinks, vacuum tubes, and so forth.

When making low-level measurements (below approximately 2 millivolts) it is important to make sure that the probe has attained a uniform temperature throughout its body. A temperature gradient between the inside and outside of the probe can generate a small thermal voltage that may add to the dc output of the detector diodes.

3.3.8 Hum, Noise, and Spurious Pick-up

When measuring low-level signals precautions should always be taken to avoid the possibility of errors of measurement resulting from hum, noise, or stray rf pick-up. Although all low-frequency hum and noise are attenuated at the input, it is still possible for unwanted high-level signals to cause errors. In some cases it may be necessary to provide extra shielding around the probe connections to reduce stray pick-up. Typical sources of spurious radiation are: induction or dielectric heating units, diathermy machines, local radio transmitters and grid dip meters.

3.4 DC OUTPUT

The dc output provided at the rear panel binding posts is a linear function (typically within 1%) of the input level, as long as the input signal is greater than 20% of full scale. For inputs less than 20% of full scale the output is NOT linear, but may be corrected by referring to paragraph 3.6 and Figure 6. Polarity of the dc output is positive with respect to the instrument ground, the nega-

tive dc output terminal being at ground potential. Output resistance is 9 kΩ.

3.5 LOW FREQUENCY MEASUREMENTS

The Model 91-12F RF Probe supplied with the Model 92B provides measurements within the specified accuracy from 10 kHz to 1.2 GHz. For measurements at lower frequencies the Model 91-4C RF Probe is available. It operates over a frequency range from 1 kHz to 250 MHz.

Important Note: After installing the Model 91-4C RF Probe, the Model 92B must be checked for accuracy of calibration, and recalibrated if required (see paragraphs 5.3 and 5.4).

3.6 CORRECTION CURVES FOR ACTUAL VOLTAGE vs METER READING

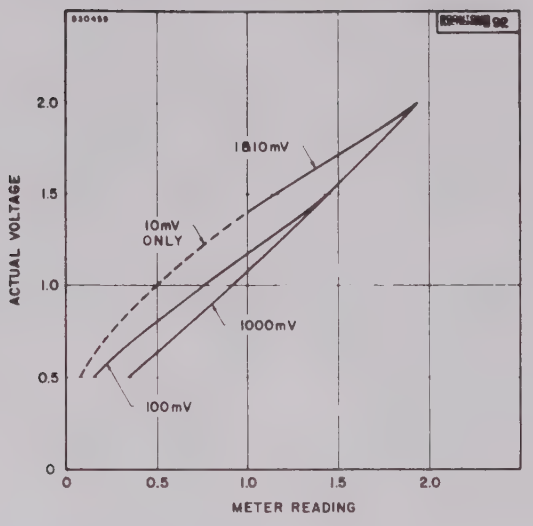
Use the curves of Figure 6 to correct for non-linearity below 20% of full scale on each range.

3.7 LOSS vs FREQUENCY CORRECTION FOR MODEL 91-8B

Use the curve of Figure 7a to make corrections for high-frequency roll-off when using the Model 91-8B 50Ω Adapter.

3.8 LOSS vs FREQUENCY CORRECTION CURVE FOR MODEL 91-14A

Use the curve of Figure 7b to make corrections for transmission loss when using the Model 91-14A Type N Tee Adapter.



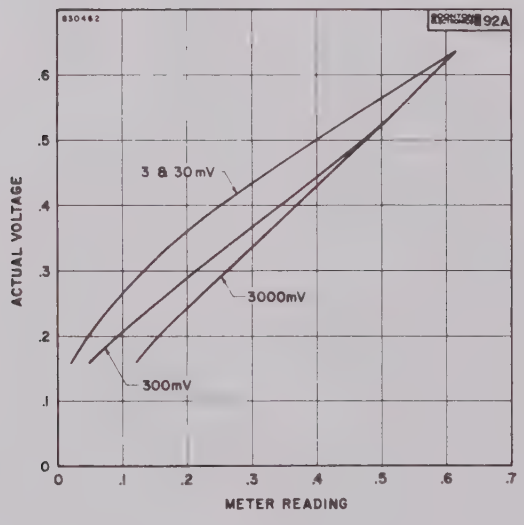
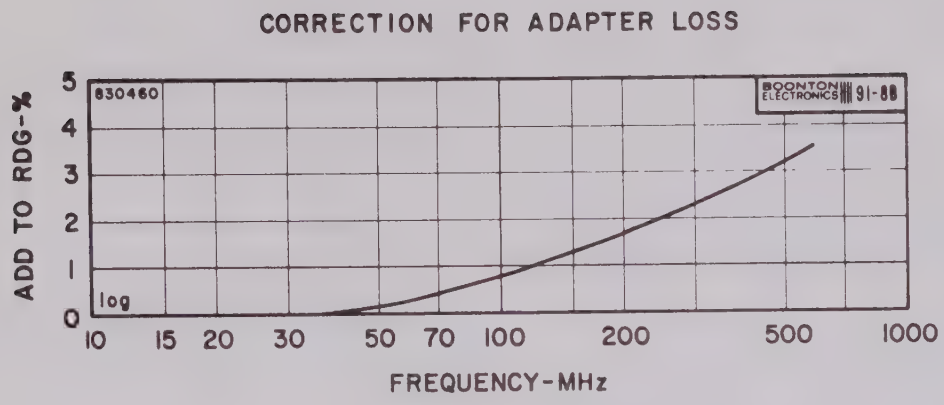


Figure 6. Correction Curves, Actual Voltage vs Meter Reading



EXAMPLE:
AT 250MHz, METER READS 50mV.
ADD 2%. TRUE VOLTAGE IS 51mV.

Figure 7A. Model 91-8B 50Ω BNC Adapter Correction Curve

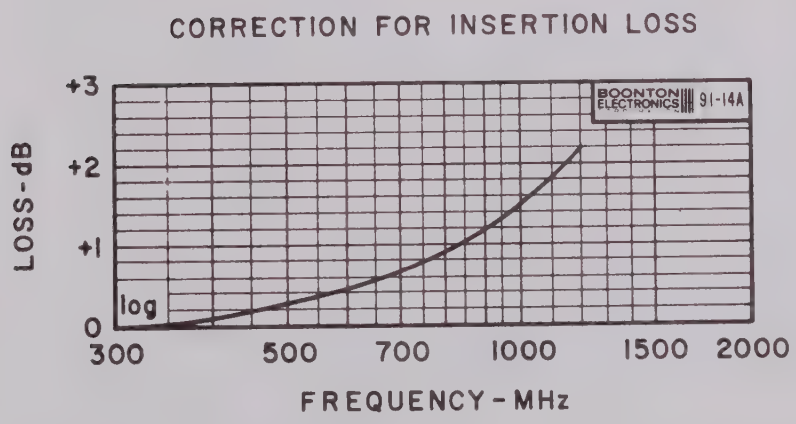


Figure 7B. Model 91-14A Type N Tee Adapter Correction Curve

CHAPTER IV

THEORY OF OPERATION

4.1 GENERAL

The operating principles of the Model 92B are shown in the following block diagram (Figure 8). The essential elements of the instrument are the probe, chopper driver, chopper, attenuator, preamplifier, amplifier, pulse generator, sync detector, shaping amplifier, panel meter and power supply.

4.1.1 RF Probe

The RF Probe embodies a full-wave diode detector which rectifies the signal under study to a dc voltage whose level is a function of the input level. While operating in the square-law region (below approximately 30 millivolts) the detector provides true rms response. As the input level increases beyond 30 millivolts, waveform response gradually approaches peak-to-peak, calibrated on the scale in rms.

In addition to increasing efficiency, use of full-wave rectification in the detector probe permits measurement of signals having highly asymmetrical waveforms without errors stemming from turn-over effect.

The diodes used in the RF Probe have been carefully selected for specific characteristics. The user is urged NOT to attempt their replacement with any off-the-shelf types. In case of damage to probe components, call your local Boonton Electronics Sales Engineering Representative or the factory for instructions.

4.1.2 Attenuator and Amplifiers

The dc output of the probe is converted to ac by the mechanical chopper. The resultant ac signal is applied to the attenuator and amplifier sections. For each range the output voltage from the 2nd amplifier is approximately 3V peak-to-peak. It is accomplished by ranging both the attenuation and the gain of the 2nd amplifier in the following manner:

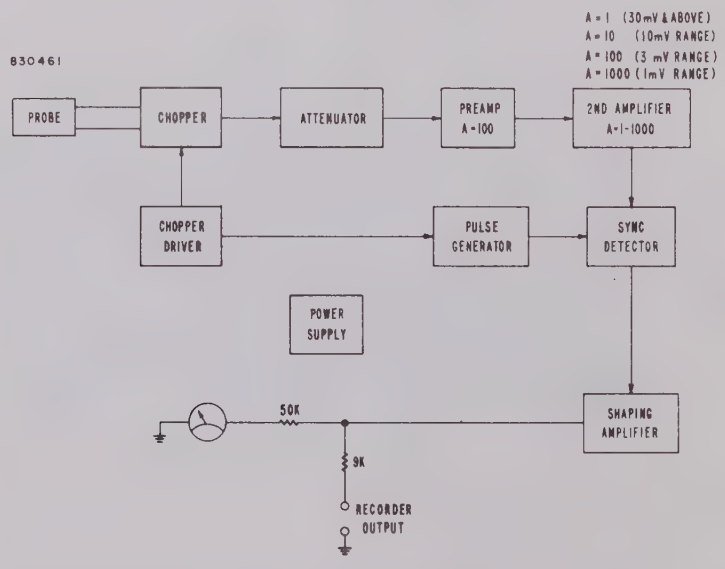


Figure 8. Block Diagram

RANGE	$\frac{1}{ATTN}$	GAIN 2nd AMP
1	1	1000
3	1	100
10	1	10
30	1	1
100	0.15	1
300	0.04	1
1000	0.01	1
3000	0.004	1

The preamplifier has a constant gain of X100, and is designed for very low input noise. Both amplifiers have moderately wide bandwidths and are stabilized by large amounts of negative feedback.

4.1.3 Synchronous Detector

The amplified ac signal from the 2nd amplifier is converted to dc by the synchronous detector. The peak-to-peak amplitude is derived from a shunt-series capacitor storage circuit using JFET switches. The synchronous detector is driven by pulses in the chopper-driver circuit, thus assuring exact synchronization. The characteristics of the detector determine the effective bandwidth of the amplifier-detector combination and allow modification of the bandwidth for different range conditions. The detector also provides conversion without offset, with excellent linearity.

4.1.4 Shaping Amplifier

The conversion of rf to dc in the probe is non-linear, the response being virtually square-law for the lowest ranges and gradually becoming quasi-linear for the 3V range. The shaping amplifier converts the non-linear output of the phase detector to a linear output by using a segmental approximation to the exact correction. The shaping amplifier is actually an operational amplifier so connected that, as the signal increases at its output, its gain is reduced by successively paralleling resistors across the feedback resistors. The number of segments required to adequately linearize the response varies from 6 for the "square-law" ranges down to 2 for the 3V range. The output of the shaping amplifier is +10V which drives the panel meter and is applied to the recorder terminals through a 9 kΩ resistor.

4.1.5 Chopper-Driver Circuits

The chopper-driver block provides all of the drive signals required by the instrument. The chopper frequency is obtained by dividing the output of a unijunction oscillator by two. The oscillator also generates the switching pulse for the synchronous detector. Diode gating feeds the pulse to the proper JFET depending upon chopper phase. The chopper frequency is normally adjusted to 94 Hz, but can be changed as much as ±10 Hz to avoid beating with harmonically related ground signals.

4.1.6 Power Supply

The power supply converts the ac input power to regulated +15V and -15V outputs. Each supply is protected by current limiting against accidental short circuits. Both supplies are adjustable to 15.0 ± 0.1V.

4.1.7 Programming

The instrument is organized around an eight-line ranging system. In each functional subcircuit the switching is accomplished by solid-state devices, generally JFET's, which are actuated by the appropriate range line. The front panel range switch simply connects to the eight range lines to allow range selection. The range lines are buffered by a logic level converter. The instrument may be externally ranged by a logic "0" command on the appropriate range line and manual disable line. (It is recommended that an Amphenol connector, or equivalent, be used for remote programming connection.)

CHAPTER V

MAINTENANCE

NOTE: Values and tolerances shown in this section are not specifications but are provided only as guides to the maintenance and calibration of this instrument.

5.1 PERIODIC CALIBRATION

The Model 92B is designed to provide trouble-free operation over extended periods of time. However, as with any precision instrument, the instrument should be checked periodically to verify proper calibration. To make such calibration checks, the following equipment is required:

a. A reliable signal source of 200 kHz to 500 kHz with less than 1% distortion at levels up to 3 volts across 50 ohms.

b. A precision voltmeter such as the Ballantine Model 310A or 300H, the Boonton Electronics Model 93A or 93AD, or the Hewlett-Packard Model 400D or 400H or equivalent.

NOTE: A Boonton Model 26A RF Millivoltmeter Calibrator can be substituted for items a. and b. above. This calibrator provides 1 MHz voltages from 60 μV to 3 V with an uncertainty of < ± 0.5% of indication. Full scale voltages in a 1 - 3 - 10 sequence can be switch-selected. On any range, incremental voltages can also be selected in 10% fs steps.

c. A precision dc voltmeter capable of measuring ±15.0V with an accuracy of 0.25%.

d. Frequency counter such as Monsanto Model 100A.

5.2 PRECAUTIONS WHEN CHECKING CALIBRATION

When checking the calibration of an instrument having the sensitivity and bandwidth of the Model 92B, it is essential to take precautions against errors resulting from stray pick-up voltages. (See paragraph 3.3.8.) A well-shielded signal source must be used in conjunction with coaxial connections to both the Model 92B and the standard reference meter. Even with a well-shielded generator and connections, it is sometimes possible for the reference meter to pick up stray rf signals and feed them into the probe. It is advisable to test for this condition by disconnecting the standard meter and noting any change in level.

5.3 CALIBRATION CHECK

Using the equipment listed in paragraph 5.1, check the calibration of the Model 92B on each range using a test voltage equal to the full scale value. If the check reveals that recalibration is required, the procedure outlined in paragraph 5.4 should be followed.

5.4 CALIBRATION PROCEDURE

The Model 92B should be calibrated at room temperature (74°F) after a minimum warm-up time of five minutes.

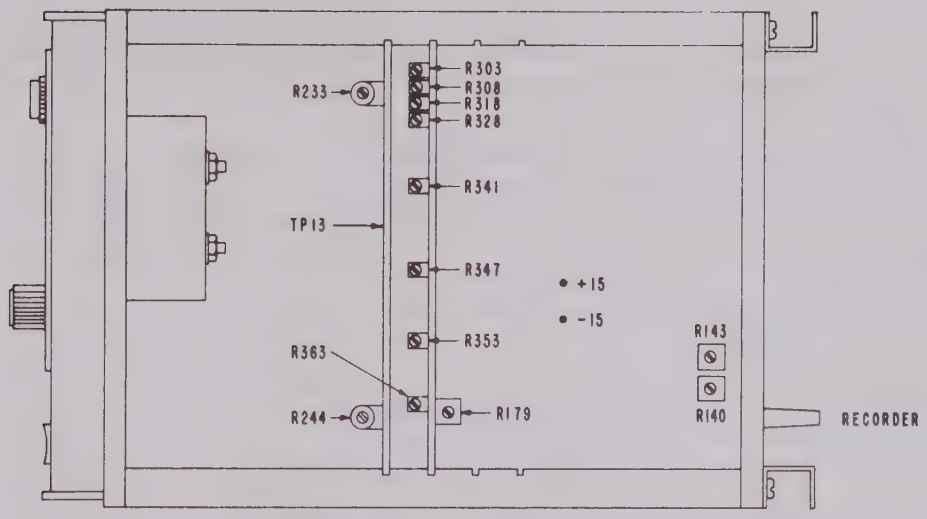
A calibration outline is provided inside the top cover of the instrument (see Figure 9). The adjustment references listed below are the same as those recorded on the top cover.

Adjustment No. 1. Measure the -15.0 V supply voltage at the 15 V Test Point located on the Main Amplifier board at C119. Adjust R143 to -15.0 ± 0.1 V.

Adjustment No. 2. Measure the +15.0 V supply voltage at the +15 V Test Point located on the Main Amplifier board at C118. Adjust R140 for a reading of +15.0 ± 0.1 V.

Adjustment No. 3. Set the FULL SCALE range selector to the 1000 mV range, apply 1000 mV input and measure the chopper frequency at Test Point 13, located on the Chopper-Driver board. Adjust R244 for a frequency of 94 ± 1 Hz (106.4 mS). In some cases it may be desirable to offset the chopper frequency to avoid beating with a

STABO LABORATORIES



• TEST POINT
+ REPEAT STEP *4

ADJ NO	CONT	FUNCTION	RANGE	INPUT ±0.2%	ADJUST
1	R143	-15 V ADJ	—	0	-15.0V ±0.1V AT -15V TP
2	R140	+15 V ADJ	—	0	+15.0V ±0.1V AT +15V TP
3	R244	CHOPPER FREQUENCY	1000 mV	1000 mV	94±1Hz AT TP 13
4	R401	FRONT PANEL ZERO	1 mV	0	AVERAGE ZERO INDICATION
5	R233	DC ZERO	30 mV	0	ZERO INDICATION
6	R353	RANGE ADJ	1000 mV	1000 mV	+10.00V AT RECORDER TERMINALS DC VOLTMETER INPUT > 10 M OHMS
7	R179	METER FS ADJ	1000 mV	1000 mV	1000 mV INDICATION
8	R363	RANGE ADJ	3000 mV	3000 mV	3000 mV INDICATION
9 +	R303	RANGE ADJ	1 mV	1 mV	1.000 mV INDICATION
10+	R308	RANGE ADJ	3 mV	3 mV	3.000 mV INDICATION
11+	R318	RANGE ADJ	10 mV	10 mV	10.00 mV INDICATION
12	R328	RANGE ADJ	30 mV	30 mV	30.00 mV INDICATION
13	R341	RANGE ADJ	100 mV	100 mV	100.0 mV INDICATION
14	R347	RANGE ADJ	300 mV	300 mV	300.0 mV INDICATION

Figure 9. Calibration Instructions

harmonic of the power line frequency. Any frequency within the adjustment range will not degrade the performance of the instrument.

Adjustment No. 4. Set the FULL SCALE range selector to the 1 mV range and zero the instrument as described in paragraph 3.3.5

Adjustment No. 5. Set the FULL SCALE range selector to the 30 mV range and adjust R233 for a zero reading at the RECORDER terminals on the back panel.

Adjustment No. 6. Set the FULL SCALE range selector to the 1000 mV range and apply 1000 mV input; adjust R353 for +10.00 V at the RECORDER terminals.

Adjustment No. 7. Set the FULL SCALE range selector to the 1000 mV range and apply 1000 mV input; adjust R179 for a 1000 mV indication.

Adjustment No. 8. Set the FULL SCALE range selector to the 3000 mV range and apply 3000 mV input; adjust R363 for a 3000 mV indication.

Adjustment No. 9. Set the FULL SCALE range selector to the 1 mV range (zero the instrument as in Adjustment No. 4), apply 1.000 mV input, and adjust R303 for a reading of 1.000 mV.

Adjustment No. 10. Set the FULL SCALE range selector to the 3 mV range (zero as in Adjustment No. 4), apply 3.000 mV input, and adjust R308 for a reading of 3.000 mV.

Adjustment No. 11. Set the FULL SCALE range selector to the 10 mV range (zero as in Adjustment No. 4), apply 10.00 mV, and adjust R318 for a reading of 10.00 mV.

Adjustment No. 12. Set the FULL SCALE range selector to the 30 mV range, apply 30.00 mV input, and adjust R328 for a reading of 30.00 mV.

Adjustment No. 13. Set the FULL SCALE range selector to the 100 mV range, apply 100.0 mV input, and adjust R341 for a reading of 100.0 mV.

Adjustment No. 14. Set the FULL SCALE range selector to the 300 mV range, apply 300.0 mV input, and adjust R347 for an indication of 300.0 mV.

5.5 TROUBLE-SHOOTING PROCEDURE

The following trouble-shooting procedures describe the instrument's cover removal, chopper replacement and voltage and resistance tests.

5.5.1 Cover Removal

The cover of the instrument may be removed from the case by removing the screw on the top of the case.

5.5.2 Chopper Replacement

If unsatisfactory operation of the Model 92B develops, a replacement chopper should be tried. (NOTE: The chopper used in the Model 92B is a special Boonton Electronics Corporation part. For replacements or spares, call your local Boonton Electronics Representative, or the factory.) If the new chopper does not clear the difficulty, place the original chopper back in the socket. The calibration accuracy should be re-checked after replacement.

5.5.3 Voltage and Resistance Tests

After determining that the trouble cannot be cured by replacement of the chopper (as noted above) it is advisable to make a systematic check of the ac voltage, dc voltage, and resistance. Once the trouble has been found and corrected, the calibration must be re-checked and readjusted as outlined in paragraphs 5.3 and 5.4.

5.5.4 Test Points

Test points, waveforms, and related test voltages are shown in the Model 92B schematics.

5.5.5 Replacement of RF Probes

The serial number of the Model 92B matches that of the Model 91-12F RF Probe with which it was calibrated at the factory. If it is necessary to change probes for any reason, the instrument's calibration MUST be re-checked. In most cases, full recalibration (see procedure in paragraph 5.4) will be required. Similarly, if the RF Probe

supplied with the instrument is exchanged for a Model 91-4C Low Frequency Probe, recalibration will be required. (See Paragraph 3.5.)

5.5.6 Probe Tests

The probe assemblies furnished with the Model 92B can be checked for VSWR and frequency response by following the procedures detailed in the paragraphs below.

Should a probe exhibit out-of-tolerance performance in these tests, the user is urged not to attempt repair himself but to send it back to the factory for repair or adjustment.

A. VSWR Measurement

1. Test Equipment

a. Generator for the desired frequency range. Suggested signal sources are:
125 kHz - 175 MHz, Boonton Model 103A, or 103B
450 kHz - 520 MHz, Boonton Model 102C, or 102D
10 MHz - 1400 MHz, Wavetek Model 2001

b. Slotted line: GR Type 900 LB

c. Detector: GR Type 1241, or Boonton RF Millivoltmeter, 92B or 92C

2. Test Procedure

a. Connect the slotted line to a proper signal source, and terminate the line with the device to be tested, i.e., Boonton Model 91-14A Tee Adapter and Boonton Model 91-15A 50 Ω Termination, or Boonton Model 91-8B 50 Ω Adapter.

It is necessary that the probe and RF Millivoltmeter be connected to whichever accessory is being tested. The probe supplies a perturbation for which the accessory was designed, and which it needs, to meet its specification, and the millivoltmeter permits the test level to be set to the desired value.

b. Move the carriage of the slotted line to a point of minimum voltage, then to a point of maximum voltage, and record the values.

c. The VSWR is the ratio of the maximum and minimum voltages. The measurement can be repeated at other frequencies and levels, as required.

B. Frequency Response

The most accurate method of measuring the frequency response of the RF Probe for the RF Millivoltmeter is through the use of micropotentiometers, electrothermic ac-dc transfer instruments, and A-T (attenuator-thermoelement) voltmeters. Users who have these instruments available will be familiar with their application.

A method of suitable accuracy, compatible with the accuracy of the Model 92B, uses a point by point frequency scan in conjunction with a power divider and calibrated power meter. The method is detailed in the following paragraphs.

1. Test Equipment

   a. Signal source for the frequency range of 10 to 1200 MHz. Suggested instrument is Wavetek Model 2001, 10 - 1400 MHz. In this application the generator is manually swept.

   b. Power Divider, Weinschel Model 1506A

   c. Calibrated RF Power Meter, Boonton Model 42B/BD, or H-P Model 435A

2. Test Procedure

   a. Connect the equipment as shown in the figure below.

   b. Set the frequency of the generator to 10 MHz, and adjust the output control for the desired test level. If the response is to be measured at one level, only, a test voltage of 100 or 200 mV is recommended.

   c. Disable the output of the generator momentarily and zero the power meter. Re-establish the output level and note the reading on the power meter. Record the frequency of the generator and the reading of the 92B RF Millivoltmeter. Change the frequency, in whatever increments are desired, through the range of 10 to 1200 MHz, holding the reference reading on the power meter constant.

   d. Reverse the output ports of the power divider and repeat Step c.

   e. The correct voltmeter reading is obtained at each frequency by averaging the two readings. This virtually eliminates the influence of frequency differences of the two ports of the power divider.

   f. Further refinements can be made by filtering the output of the generator, and measuring the complex reflection coefficients of the power meter, rf millivoltmeter accessory under test, and all ports of the power divider. The usual corrections can then be made. These procedures are not usually necessary, and should be done only if the additional accuracy is warranted.

C. Frequency Response and VSWR

An alternate method of measuring both the frequency response and the VSWR (in terms of the reflection coefficient), but with somewhat reduced accuracy, employs a sweep generator, VSWR bridge, external levelling of the generator, power divider, and sensitive oscilloscope.

1. Test Equipment

   a. Sweep Generator, Wavetek Model 2001, 10 - 1400 MHz

   b. SWR Autotester, Wiltron Model 63N50

   c. Oscilloscope, Tektronix Model 5100, with two 5A20 Vertical Amplifiers

   d. Power Divider, Weinschel Model 1506

   e. Standard 1.2 : 1 Mismatch Termination, Weinschel Model M1410-1.2

2. Test Procedure

   a. Connect the equipment as shown in the Swept Frequency Response Test Setup figure, and temporarily connect the probe under test to the RF Millivoltmeter. Adjust the output control of the sweep generator for a reading on the 92B of 100 mV at a fixed frequency of 100 MHz.

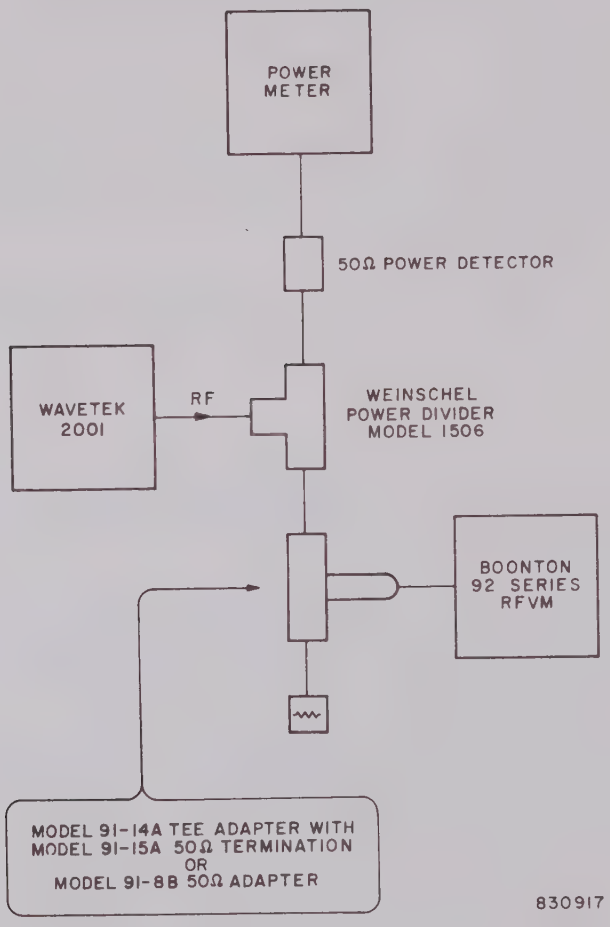
   b. Calibrate one of the vertical input amplifiers of the oscilloscope for a sensitivity of 100 μV/div. The other vertical amplifier should be calibrated so that a change from 100 mV to 90 mV applied to the input of the probe under test will produce a vertical deflection of one division. This can be done easily if a Boonton Model 26A RF Millivoltmeter Calibrator is available. The probe should be temporarily connected to the output of the calibrator while output levels of 100 mV and 90 mV are alternately selected, and the sensitivity of the second input amplifier is adjusted for a deflection of one division.

   c. Substitute the Standard 1.2 : 1 Mismatch Termination for the accessory under test, and calibrate the graticule of the oscilloscope for a VSWR of 1.2. Replace the accessory and probe.

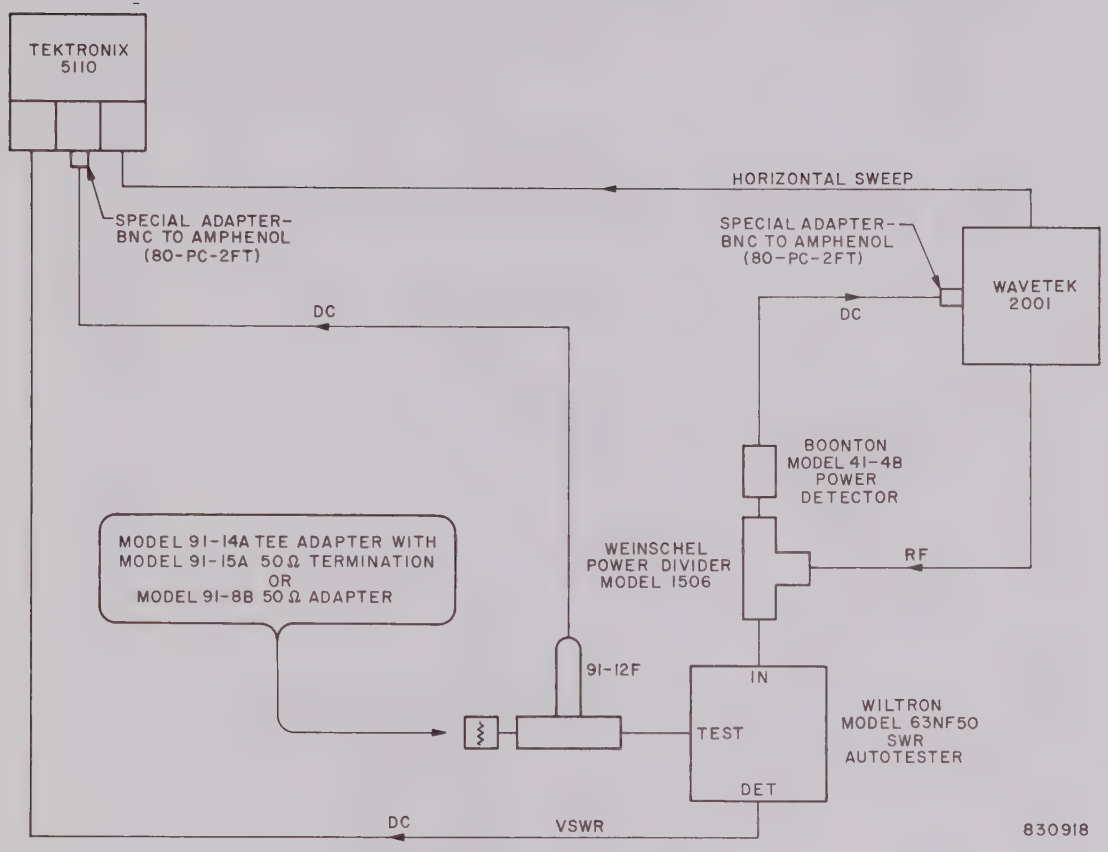
   d. Adjust the limits on the three bands of the sweep generator for coverage from 10 to 1200 MHz. Study the traces for both frequency response and VSWR (return loss).

   e. Reverse the output ports of the power divider and repeat Steps c and d.

f. It should be noted that the permissible error for the frequency response trace expands with frequency. For the most meaningful results, the graticule should be marked with a grease pencil, showing the maximum permissible errors for the various frequency bands, as determined with a calibrated signal of, say, 1 MHz, and at levels above and below the selected test level. It is important to note that the recovered dc from the rf probe, which is applied to the second vertical amplifier, will vary as the square of the rf input level for test levels of 30 mV, or less. Above 30 mV the rf to dc conversion gradually changes from square law to linear, and approaches a peak-to-peak rectifier at an input of 3 volts.


POWER METER
50Ω POWER DETECTOR
WAVETEK 2001
RF
WEINSCHEL POWER DIVIDER MODEL 1506
BOONTON 92 SERIES RFVM
MODEL 91-14A TEE ADAPTER WITH MODEL 91-15A 50Ω TERMINATION OR MODEL 91-8B 50Ω ADAPTER
830917

Frequency Response Test Setup



Swept Frequency Response Test Setup

CHAPTER VI

INTERFACE

PROGRAMMING INPUTS AND DATA OUTPUT

Pin No.	Function	Comment	Command	Unit Loading
7	Man. disable	Disables front panel range selection	0	0.1
16	1mV range	Selects range provided manual dis-	0	0.1
15	3mV "	able has also been selected; select-	0	0.1
14	10mV "	ing more than one range will result	0	0.1
13	30mV "	in incorrect indications. Range lines	0	0.1
12	100mV "	must be deselected for manual oper-	0	0.1
11	300mV "	ation.	0	0.1
10	1 V "		0	0.1
9	3 V "		0	0.1
5	Common	Power line ground at rear panel	N/A	N/A
4	DC Analog	+10V for full scale of "1" ranges +9.5V for "3" ranges	N/A	N/A

Figure 10. Pin Designations

6.1

Input Characteristics

TTL Series	Logic Level	Voltage Level	Current per Unit Load
Standard Power 54/74	0	± 0.7 V	-1.6 mA*
	1	2.4 to 5.25V	40μA

*The - current indicates current out of the input (external command device must sink this current). A standard power (Series 54/74) TTL output will sink and source 10 unit loads.

6.2

Input Pull-Up

All input terminals have internal pull-up. The current sourced by this pull - up when the input is brought to a logic level 0 is included in the loading shown in the "Unit Loading" column of the chart.

6.3

Analog Output

Source resistance is = 9 KΩ

STABRO LABORATORIES

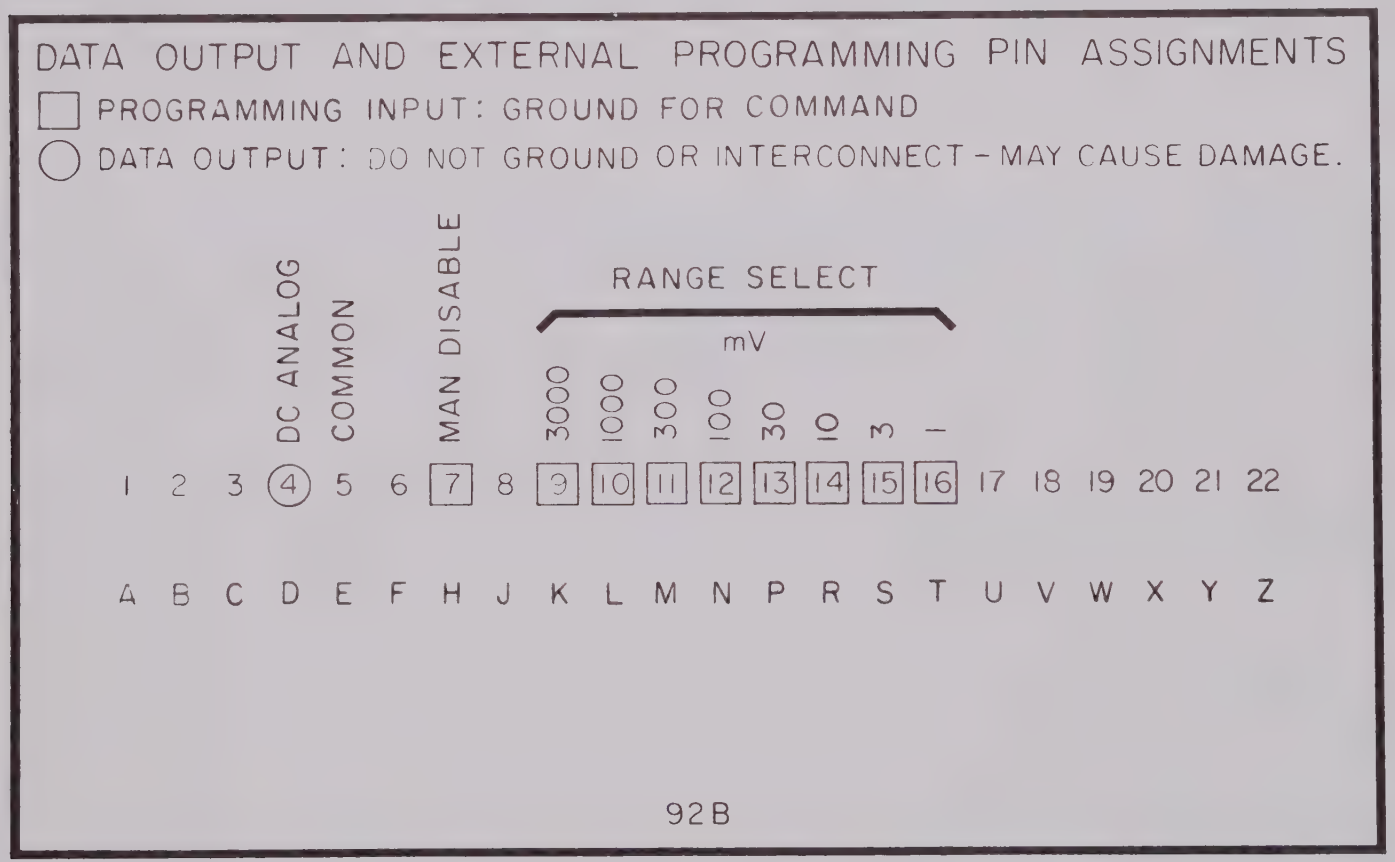

DATA OUTPUT AND EXTERNAL PROGRAMMING PIN ASSIGNMENTS
PROGRAMMING INPUT: GROUND FOR COMMAND
DATA OUTPUT: DO NOT GROUND OR INTERCONNECT - MAY CAUSE DAMAGE.
DC ANALOG COMMON
MAN DISABLE
RANGE SELECT
mV
3000
1000
300
100
30
10
3
—
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
A B C D E F H J K L M N P R S T U V W X Y Z
92B

Figure 11. External Connections

TABLE OF REPLACEABLE PARTS

Reference	Description		BEC Part No.
A201	Op. Amp.	LM310H	535005
A301	Op. Amp.	LM301AN	535012
C101	Capacitor, PE	100 nF 10% 200 V	234005
C102	Capacitor, Elec.	10 µF 20% 20 V	283205
C103	Capacitor, Mica	100 pF 5% 500 V	200001
C104	Capacitor, Elec.	10 µF 20% 20 V	283205
C105	Capacitor, Elec.	33 µF 20% 15 V	283206
C106	Capacitor, Elec.	10 µF 20% 20 V	283205
C107	Capacitor, Met.	1.0 µF 20% 100 V	236007
C108	Capacitor, Elec.	1.0 µF 20% 35 V	283199
C109	Capacitor, Elec.	50 µF 25 V	283159
C110	Capacitor, Elec.	50 µF 25 V	283159
C111	Capacitor, PE	100 nF 10% 200 V	234005
C112	Capacitor, Elec.	250 µF 40 V	283207
C113	Capacitor, Elec.	250 µF 40 V	283207
C114	Not Used		
C115	Capacitor, Cer.	0.001 µF GMV 500 V	224114
C116	Capacitor, Cer.	0.001 µF GMV 500 V	224114
C117	Not Used		
C118	Capacitor, Elec.	100 µF 25 V	283105
C119	Capacitor, Elec.	100 µF 25 V	283105
C201	Capacitor, PC	100 nF 10% 50 V	234046
C202	Capacitor, PE	6.8 nF 10% 200 V	234044
C203	Capacitor, Mica	100 pF 5% 500 V	200001
C204	Capacitor, Mica	100 pF 5% 500 V	200001
C205	Capacitor, PE	22 nF 10% 200 V	230101
C206	Capacitor, PC	100 nF 10% 50 V	234046
C207	Capacitor, Mica	100 pF 5% 500 V	200001
C208	Capacitor, PC	100 nF 10% 50 V	234046
C209	Capacitor, Cer.	10 nF 100 V	224119
C210	Capacitor, Cer.	10 nF 100 V	224119
C211	Capacitor, PE	22 nF 10% 200 V	230101
C212	Capacitor, PC	470 nF 10% 50 V	234128
C213	Capacitor, Mica	100 pF 5% 500 V	200001
C214	Capacitor, Elec.	50 µF 25 V	283159
C215	Capacitor, Elec.	50 µF 25 V	283159
C216	Capacitor, Elec.	50 µF 25 V	283159
C217	Capacitor, Elec.	150 µF -10% +75% 15 V	283307
C301	Capacitor, Cer.	10 nF 100 V	224119
C302	Capacitor, Mica	33 pF 5% 500 V	200049
C303	Capacitor, Cer.	10 nF 100 V	224119
C401	Capacitor, PC	100 nF 10% 50 V	234046
C402	Capacitor, PC	100 nF 10% 50 V	234046
CR101	Diode, Sig.	FDH300	530052
CR102	Diode, Sig.	1N914	530058
CR103	Diode, Sig.	1N914	530058
CR104	Diode, Zener	1N5243B (11 V)	530101
CR105	Diode, Zener	1N5235B (6.8 V)	530089
CR106 through CR110	Diode, Sig.	1N914	530058
CR111	Bridge, Rectifier	KBP02	532013
CR112	Bridge, Rectifier	KBP02	532013
CR113	Not Used		
CR114	Not Used		

Reference		Description	BEC Part No.
CR115	Diode, Sig.	1N914	530058
CR116	Not Used		
CR117 through CR124	Diode, Sig.	1N914	530058
CR201 through CR218	Diode, Sig.	1N914	530058
CR219	Diode, Sig.	FDH300	530052
CR301 through CR308	Diode, Sig.	1N914	530058
DS401	Lamp	Tungsol 349	545107
DS402	Lamp	Tungsol 349	545107
F401	Fuse	MDL 1/16 A 250 V	545538
F401	Fuse, Slo-Blo	MDL 1/10 A 250 V	545519
G401	Chopper	Special	540126
IC101	Regulator	µA7805	535011
IC102	Regulator	µA7805	535011
IC103	Not Used		
IC104	Regulator	LM723CN	535037
IC105	Regulator	LM723CN	535037
J101	Connector, Card Edge 22 Pos. Amphenol 143-022-03		479231
J102	Connector, Card Edge 22 Pos. Amphenol 143-022-03		479231
J401	Receptacle	Amphenol 80-PC-2FT	479119
M401	Meter & Scale	API	554216
Q101	Transistor, FET	2N5949	528019
Q102	Transistor, FET	2N5949	528019
Q103	Not Used		
Q104	Transistor, FET	2N5949	528019
Q105	Transistor, FET	TIS58	528038
Q106	Transistor, FET	3N161	528132
Q107	Transistor, FET	3N161	528132
Q108	Transistor, FET	2N5949	528019
Q109	Transistor, Selected	TIS58	528044
Q110	Transistor, NPN	2N5088	528047
Q111	Transistor, PNP	2N5087	528042
Q112	Transistor, PNP	D39C2	528048
Q113	Transistor, PNP	2N5087	528042
Q114	Transistor, NPN	2N5088	528047
Q115	Transistor, FET	TIS58	528038
Q116	Transistor, FET	TIS58	528038
Q117	Transistor, FET	TIS58	528038
Q118	Transistor, FET	2N5949	528019
Q119	Transistor, FET	2N5949	528019
Q120	Transistor, FET	2N5949	528019
Q121	Transistor, PNP	D39C2	528048
Q122	Transistor, PNP	MPS-6516	528037
Q123	Not Used		

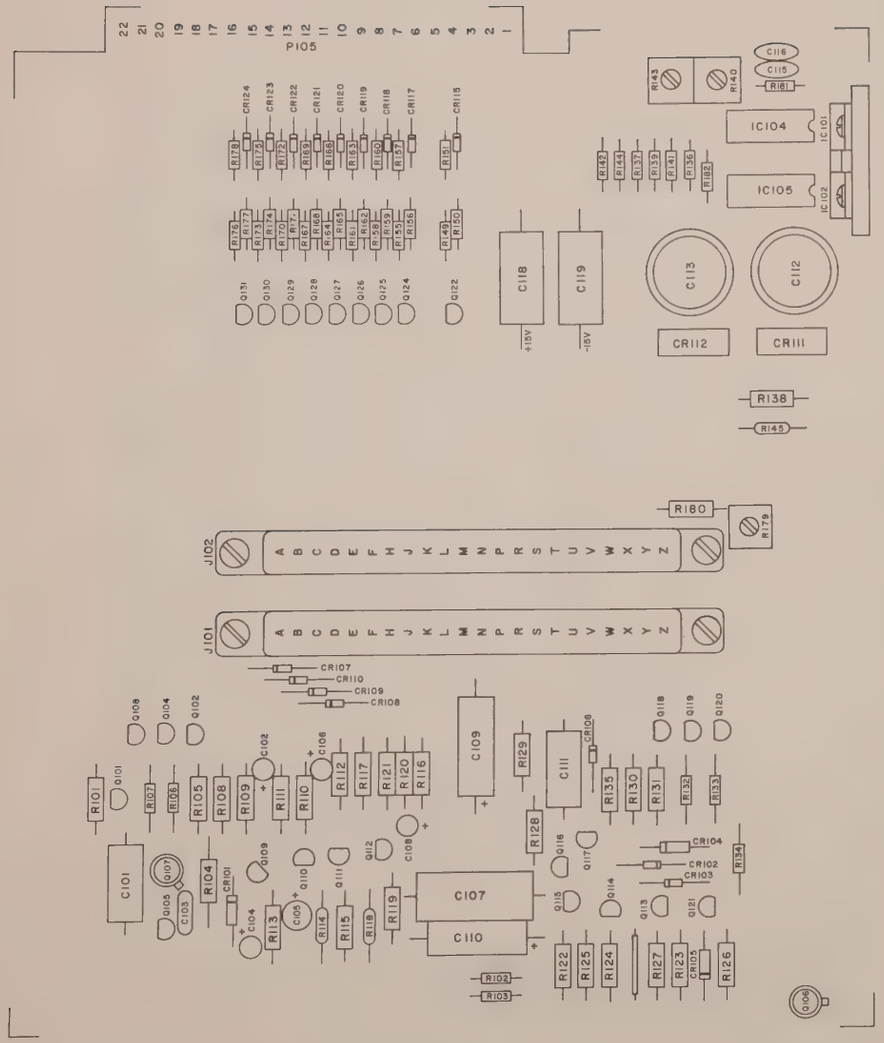
Reference	Description		BEC Part No.
Q124 through Q131	Transistor, PNP	MPS-6516	528037
Q201	Transistor, Uni.	2N4871	528051
Q202	Transistor, NPN	MPS-A20	528043
Q203	Transistor, PNP	2N5087	528042
Q204	Transistor, NPN	2N5088	528047
Q205	Transistor, NPN	MPS-A20	528043
Q206	Transistor, FET	MPS-A12	528052
Q207	Transistor, NPN	MPS-A20	528043
Q208	Transistor, FET	TIS58	528093
Q209	Transistor, NPN	MPS-A20	528043
Q210	Transistor, FET	TIS58	528093
Q211	Transistor, FET	2N5949	528019
Q212	Transistor, NPN	MPS-A20	528043
Q213	Transistor, NPN	2N5308	528050
Q214	Transistor, NPN	2N5308	528050
Q301	Transistor, FET	2N5949	528019
Q302	Transistor, FET	2N5949	528019
Q303	Transistor, FET	2N5949	528019
Q304	Transistor, PNP	2N5087	528042
Q305	Transistor, FET	2N5949	528019
Q306	Transistor, PNP	2N5087	528042
Q307	Transistor, FET	2N5949	528019
Q308	Transistor, PNP	2N5087	528042
Q309	Transistor, FET	2N5949	528019
Q310	Transistor, PNP	2N5087	528042
Q311	Transistor, FET	2N5949	528019
Q312	Transistor, PNP	2N5087	528042
Q313 through Q316	Transistor, FET	2N5949	528019
Q317	Transistor, PNP	2N5087	528042
Q318	Transistor, NPN	2N5088	528047
Q319	Transistor, PNP	2N5087	528042
Q320	Transistor, NPN	2N5088	528047
Q321	Transistor, PNP	2N5087	528042
Q322	Transistor, PNP	2N5087	528042
Q323	Transistor, FET	2N5949	528019
Q324	Transistor, FET	2N5949	528019
Q325	Transistor, PNP	2N5087	528042
Q326	Transistor, FET	2N5949	528019
Q327	Transistor, PNP	2N5087	528042
Q328	Transistor, FET	2N5949	528019
Q329	Transistor, PNP	2N5087	528042
Q330	Transistor, FET	2N5949	528019
Q331	Transistor, FET	2N5949	528019
Q332	Transistor, PNP	2N5087	528042
Q333	Transistor, PNP	2N5087	528042
Q334	Transistor, PNP	2N5087	528042
Q335	Transistor, FET	2N5949	528019
Q336	Transistor, FET	2N5949	528019
Q337	Transistor, PNP	2N5087	528042
Q338	Transistor, PNP	2N5087	528042
Q339	Transistor, PNP	2N5087	528042
R101	Resistor, Comp.	1 MΩ 5%	344600
R102	Resistor, Comp.	6.2 kΩ 5%	343376

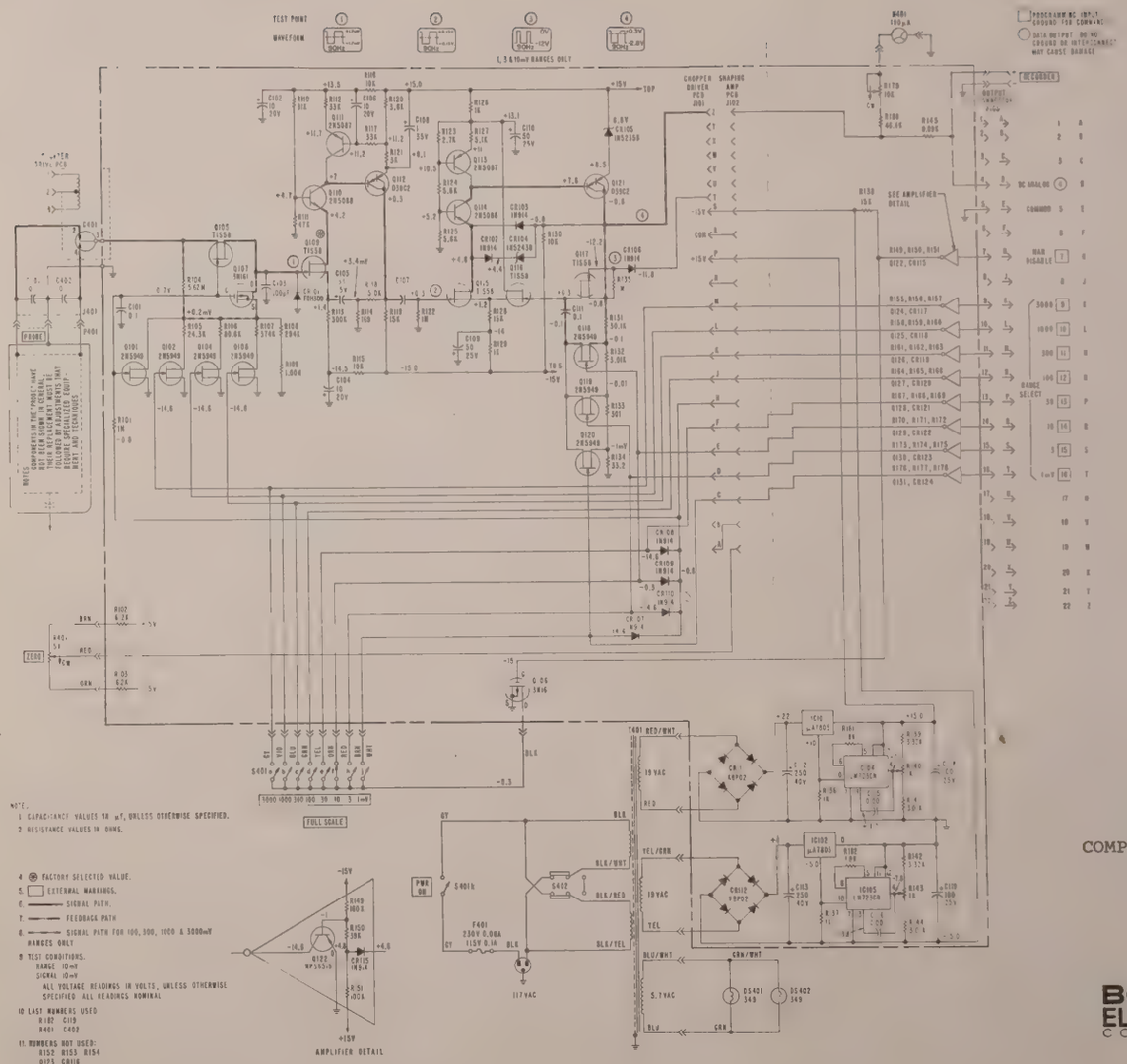
Reference		Description	BEC Part No.
R103	Resistor, Comp.	6.2 kΩ 5%	343376
R104	Resistor, MF	5.6 MΩ 1% 1/4 W	325397
R105	Resistor, MF	24.3 kΩ 1%	341437
R106	Resistor, MF	80.6 kΩ 1%	341487
R107	Resistor, MF	374 kΩ 1%	341555
R108	Resistor, MF	294 kΩ 1%	341545
R109	Resistor, MF	1.0 MΩ 1%	342600
R110	Resistor, Comp.	91 kΩ 5%	344492
R111	Resistor, Comp.	47 kΩ 5%	344465
R112	Resistor, Comp.	33 kΩ 5%	344450
R113	Resistor, Comp.	300 kΩ 5%	344546
R114	Resistor, MF	169 Ω 1%	341222
R115	Resistor, Comp.	10 kΩ 5%	344400
R116	Resistor, Comp.	10 kΩ 5%	344400
R117	Resistor, Comp.	33 kΩ 5%	344450
R118	Resistor, MF	15 kΩ 1%	341417
R119	Resistor, Comp	15 kΩ 5%	344417
R120	Resistor, Comp.	3.6 kΩ 5%	344353
R121	Resistor, Comp.	3 kΩ 5%	344346
R122	Resistor, Comp.	1 MΩ 5%	344600
R123	Resistor, Comp.	2.7 kΩ 5%	344341
R124	Resistor, Comp.	5.6 kΩ 5%	344372
R125	Resistor, Comp.	5.6 kΩ 5%	344372
R126	Resistor, Comp.	1 kΩ 5%	344300
R127	Resistor, Comp.	5.1 kΩ 5%	344368
R128	Resistor, Comp.	15 kΩ 5%	344417
R129	Resistor, Comp.	1 kΩ 5%	344300
R130	Resistor, Comp	10 kΩ 5%	344400
R131	Resistor, MF	30.1 kΩ 1%	341446
R132	Resistor, MF	3.01 kΩ 1%	341346
R133	Resistor, MF	301 Ω 1%	341246
R134	Resistor, MF	33.2 Ω 1%	341150
R135	Resistor, Comp.	1 MΩ 5%	344600
R136	Resistor, Comp.	1 kΩ 5%	343300
R137	Resistor, Comp.	1 kΩ 5%	343300
R138	Resistor, Comp.	15 kΩ 5%	344417
R139	Resistor, MF	3.32 kΩ 1%	341350
R140	Resistor, Var.	1 kΩ 10% 1/2 W	311316
R141	Resistor, MF	3.01 kΩ 1%	341346
R142	Resistor, MF	3.32 kΩ 1%	341350
R143	Resistor, Var.	1 kΩ 10% 1/2 W	311316
R144	Resistor, MF	3.01 kΩ 1%	341346
R145	Resistor, MF	9.09 kΩ 1%	341392
R146 through R148	Not Used		
R149	Resistor, Comp.	160 kΩ 5%	343520
R150	Resistor, Comp.	39 kΩ 5%	343457
R151	Resistor, Comp.	100 kΩ 5%	343500
R152 through R154	Not Used		
R155	Resistor, Comp.	160 kΩ 5%	343520
R156	Resistor, Comp.	39 kΩ 5%	343457
R157	Resistor, Comp.	100 kΩ 5%	343500
R158	Resistor, Comp.	160 kΩ 5%	343520
R159	Resistor, Comp.	39 kΩ 5%	343457
R160	Resistor, Comp.	100 kΩ 5%	343500
R161	Resistor, Comp.	160 kΩ 5%	343520
R162	Resistor, Comp.	39 kΩ 5%	343457

Reference		Description	BEC Part No.
R163	Resistor, Comp.	100 kΩ 5%	343500
R164	Resistor, Comp.	160 kΩ 5%	343520
R165	Resistor, Comp.	39 kΩ 5%	343457
R166	Resistor, Comp.	100 kΩ 5%	343500
R167	Resistor, Comp.	160 kΩ 5%	343520
R168	Resistor, Comp.	39 kΩ 5%	343457
R169	Resistor, Comp.	100 kΩ 5%	343500
R170	Resistor, Comp.	160 kΩ 5%	343520
R171	Resistor, Comp.	39 kΩ 5%	343457
R172	Resistor, Comp.	100 kΩ 5%	343500
R173	Resistor, Comp.	160 kΩ 5%	343520
R174	Resistor, Comp.	39 kΩ 5%	343457
R175	Resistor, Comp.	100 kΩ 5%	343500
R176	Resistor, Comp.	160 kΩ 5%	343520
R177	Resistor, Comp.	39 kΩ 5%	343457
R178	Resistor, Comp.	100 kΩ 5%	343500
R179	Resistor, Var.	10 kΩ 10% 1/2 W	311328
R180	Resistor, MF	46.4 kΩ 1%	341464
R181	Resistor, Comp.	1.8 kΩ 5%	343325
R182	Resistor, Comp.	1.8 kΩ 5%	343325
R201	Resistor, Comp.	10 kΩ 5%	344400
R202	Resistor, Comp.	22 kΩ 5%	344433
R203	Resistor, Comp.	10 kΩ 5%	344400
R204	Resistor, Comp.	100 Ω 5%	344200
R205	Resistor, Comp.	33 kΩ 5%	344450
R206	Resistor, Comp.	10 kΩ 5%	344400
R207	Resistor, Comp.	100 kΩ 5%	344500
R208	Resistor, Comp.	3.3 kΩ 5%	344350
R209	Resistor, Comp.	4.7 kΩ 5%	344365
R210	Resistor, Comp.	10 kΩ 5%	344400
R211	Resistor, Comp.	150 kΩ 5%	344517
R212	Resistor, Comp.	10 kΩ 5%	344400
R213	Resistor, Comp.	10 kΩ 5%	344400
R214	Resistor, Comp.	22 kΩ 5%	344433
R215	Resistor, Comp.	10 kΩ 5%	344400
R216	Resistor, Comp.	270 kΩ 5%	344541
R217	Resistor, Comp.	240 kΩ 5%	344537
R218	Resistor, Comp.	10 kΩ 5%	344400
R219	Resistor, Comp.	15 kΩ 5%	344417
R220	Resistor, Comp.	10 kΩ 5%	344400
R221	Resistor, Comp.	10 kΩ 5%	344400
R222	Resistor, Comp.	10 kΩ 5%	344400
R223	Resistor, Comp.	4.7 kΩ 5%	344365
R224	Resistor, Comp.	12 kΩ 5%	344408
R225	Resistor, Comp.	100 kΩ 5%	344500
R226	Resistor, Comp.	100 kΩ 5%	344500
R227	Resistor, Comp.	15 kΩ 5%	344417
R228	Resistor, Comp.	10 kΩ 5%	344400
R229	Resistor, Comp.	100 kΩ 5%	344500
R230	Resistor, Comp.	12 kΩ 5%	344408
R231	Resistor, Comp.	4.7 kΩ 5%	344365
R232	Resistor, Comp.	100 kΩ 5%	344500
R233	Resistor, Var.	2 kΩ 20% 1/2 W	311285
R234	Resistor, Comp.	100 kΩ 5%	344500
R235	Resistor, Comp.	100 kΩ 5%	344500
R236	Resistor, Comp.	27 kΩ 5%	344441
R237	Resistor, Comp.	100 kΩ 5%	344500
R238	Resistor, Comp.	100 kΩ 5%	344500
R239	Resistor, Comp.	1.6 kΩ 5%	344320

Reference		Description	BEC Part No.
R240	Resistor, Comp.	300 Ω 5%	344246
R241	Resistor, Comp.	200 Ω 5% 1 W	302082
R242	Resistor, Comp.	150 kΩ 5%	344517
R243	Resistor, Comp.	510 kΩ 5%	344568
R244	Resistor, Var.	50 kΩ 20% 1/2 W	311282
R245	Resistor, Comp.	47 Ω 5%	344165
R301	Resistor, Comp.	130 Ω 5%	344211
R302	Resistor, Comp.	4.7 MΩ 5%	344665
R303	Resistor, Var.	1 kΩ 10% 1 W	311256
R304	Resistor, MF	10 kΩ 1%	341400
R305	Resistor, Comp.	4.7 MΩ 5%	344665
R306	Resistor, MF	51.1 kΩ 1%	341468
R307	Resistor, MF	2.49 kΩ 1%	341338
R308	Resistor, Var.	1 kΩ 10% 1 W	311256
R309	Resistor, MF	28.7 kΩ 1%	341444
R310	Resistor, MF	200 kΩ 1%	341529
R311	Resistor, MF	100 kΩ 1%	341500
R312	Resistor, MF	40.2 kΩ 1%	341458
R313	Resistor, MF	191 kΩ 1%	341527
R314	Resistor, MF	11 kΩ 1%	341404
R315	Resistor, Comp.	4.7 MΩ 5%	344665
R316	Resistor, MF	29.4 kΩ 1%	341445
R317	Resistor, MF	95.3 kΩ 1%	341494
R318	Resistor, Var.	1 kΩ 10% 1 W	311256
R319	Resistor, MF	28.0 kΩ 1%	341443
R320	Resistor, MF	64.9 kΩ 1%	341478
R321	Resistor, MF	1.00 MΩ 1%	342600
R322	Resistor, MF	26.1 kΩ 1%	341440
R323	Resistor, MF	46.4 kΩ 1%	341464
R324	Resistor, MF	10 kΩ 1%	341400
R325	Resistor, Comp.	4.7 MΩ 5%	344665
R326	Resistor, MF	45.3 kΩ 1%	341463
R327	Resistor, MF	2.49 kΩ 1%	341338
R328	Resistor, Var.	1 kΩ 10% 1 W	311256
R329	Resistor, Comp.	270 kΩ 5%	344541
R330	Resistor, MF	21.5 kΩ 1%	341432
R331	Resistor, MF	240 kΩ 1%	341536
R332	Resistor, Comp.	18 kΩ 5%	344425
R333	Resistor, MF	26.1 kΩ 1%	341440
R334	Resistor, MF	154 kΩ 1%	341518
R335	Resistor, Comp.	47 kΩ 5%	344465
R336	Resistor, MF	54.9 kΩ 1%	341471
R337	Resistor, MF	191 kΩ 1%	341527
R338	Resistor, Comp.	4.7 MΩ 5%	344665
R339	Resistor, MF	82.5 kΩ 1%	341488
R340	Resistor, MF	178 kΩ 1%	341524
R341	Resistor, Var.	1 kΩ 10% 1 W	311256
R342	Resistor, MF	17.8 kΩ 1%	341424
R343	Resistor, MF	2.74 kΩ 1%	341342
R344	Resistor, Comp.	4.7 MΩ 5%	344665
R345	Resistor, MF	24.3 kΩ 1%	341437
R346	Resistor, MF	232 kΩ 1%	341535
R347	Resistor, Var.	1 kΩ 10% 1 W	311256
R348	Resistor, MF	95.3 kΩ 1%	341494
R349	Resistor, MF	453 kΩ 1%	341563
R350	Resistor, Comp.	4.7 MΩ 5%	344665
R351	Resistor, MF	200 kΩ 1%	341529
R352	Resistor, MF	634 kΩ 1%	342577
R353	Resistor, Var.	1 kΩ 10% 1 W	311256

Reference		Description	BEC Part No.
R354	Resistor, MF	14.3 kΩ 1%	341415
R355	Resistor, MF	2.49 kΩ 1%	341338
R356	Resistor, MF	34.8 kΩ 1%	341452
R357	Resistor, MF	523 kΩ 1%	342569
R358	Resistor, Comp.	4.7 MΩ 5%	344665
R359	Resistor, MF	162 kΩ 1%	341520
R360	Resistor, MF	806 kΩ 1%	342587
R361	Resistor, MF	10 kΩ 1%	341400
R362	Resistor, MF	2.74 kΩ 1%	341342
R363	Resistor, Var.	1 kΩ 10% 1 W	311256
R364	Resistor, MF	127 kΩ 1%	341510
R365	Resistor, MF	604 kΩ 1%	342575
R401	Resistor, Var.	5 kΩ 20% 2 W	311255
RT301	Thermistor	100 Ω 10%	325005
S401	Switch	Pushbutton	465146
S402	Switch	Slide	465134
T401	Transformer	Power	446068





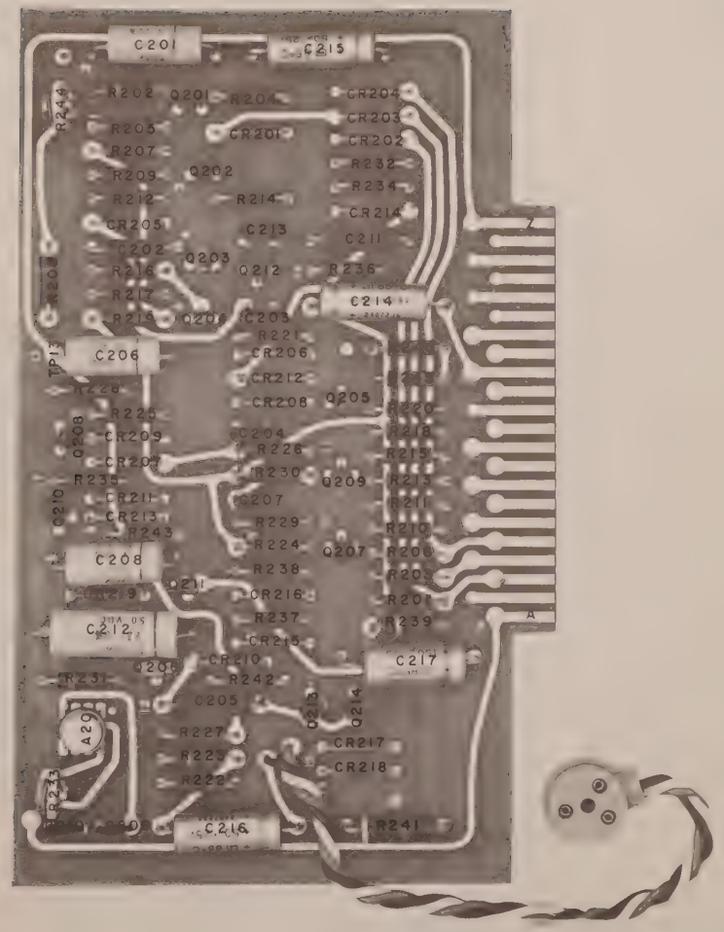
STABRO LABORATORIES

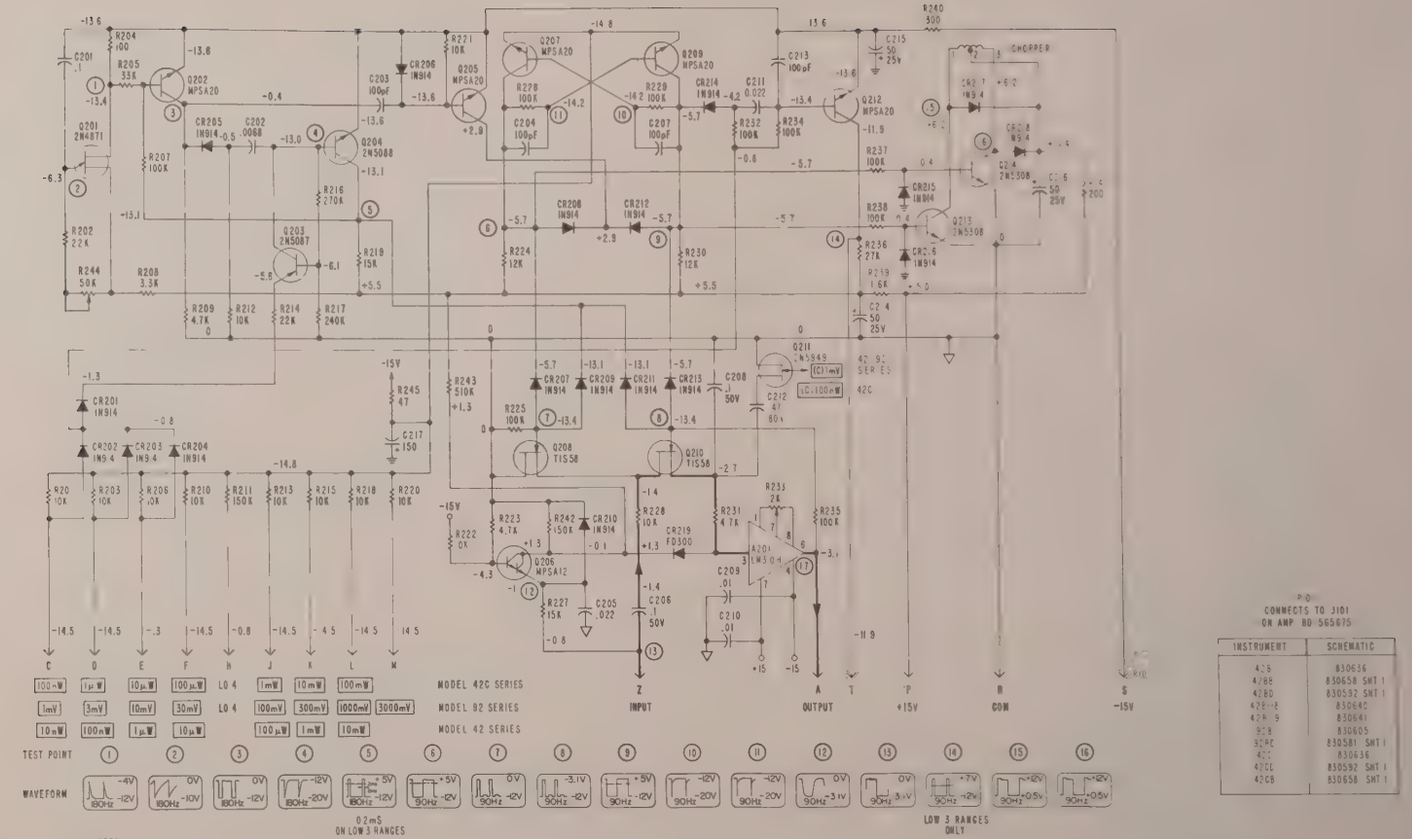
COMPONENT NUMBERS

100 SERIES

BOONTON ELECTRONICS CORPORATION

MODEL 92B
Schematic, Amplifier
E830605D





CONNECTS TO J101 ON AMP BD 565675

INSTRUMENT	SCHEMATIC
42B	830636
42BB	830658 SHT 1
42BD	830592 SHT 1
42B-B	830640
42B-D	830641
92B	830605
92BB	830581 SHT 1
42C	830636
42CC	830592 SHT 1
42CB	830658 SHT 1

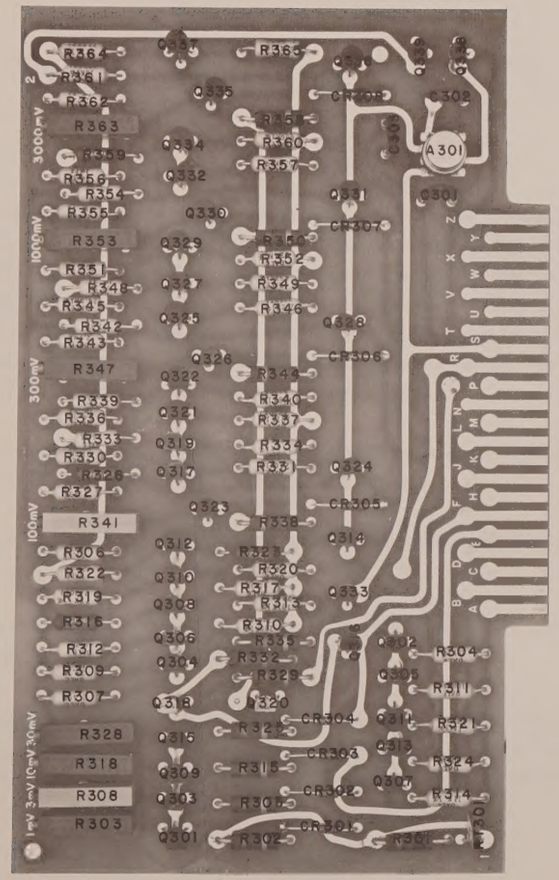
NOTES

1. CAPACITANCE VALUES IN μF, UNLESS OTHERWISE SPECIFIED
2. RESISTANCE VALUES IN OHMS
3. ☐ EXTERNAL MARKINGS.
4. ▽ COMMON
5. ——— SIGNAL PATH
6. TEST CONDITIONS: 10mV RANGE / 10mV SIGNAL } 42,92 SERIES; 10 μW RANGE / 10 μW SIGNAL } 42C ONLY
   ALL VOLTAGES NOMINAL. ALL READINGS IN VOLTS, UNLESS OTHERWISE SPECIFIED.
8. LAST NUMBERS USED: R245 C217 Q214 CR218 A201

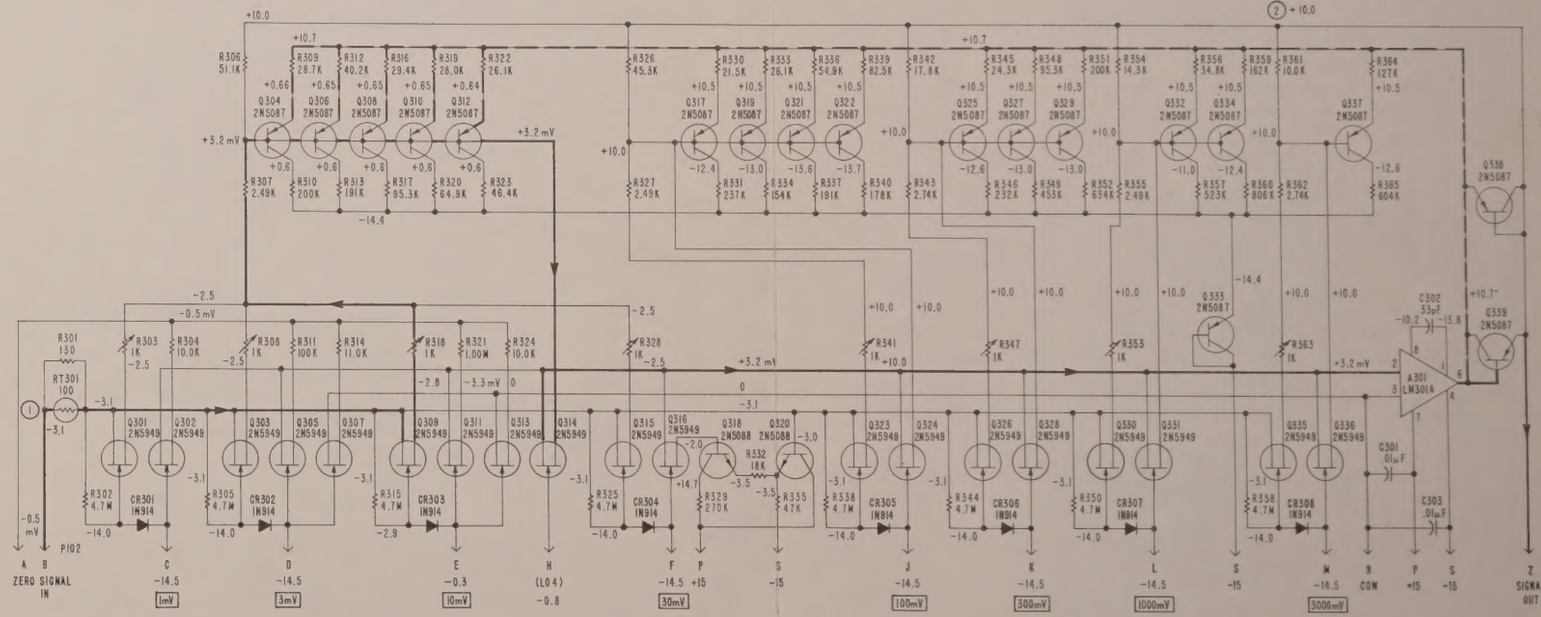
COMPONENT NUMBERS
200 SERIES

BOONTON ELECTRONICS CORPORATION

MODEL 42B,BB,BD,C,CB,CD,
92B,BB,BD
Schematic, Chopper Driver
D830581L (Sheet 3 of 3)



NOTES:
1. RESISTANCE VALUES IN OHMS.
2. SIGNAL PATH ———
3. FEEDBACK PATH ———•———
4. ▭ EXTERNAL MARKINGS
5. LAST NUMBER USED:
   R365 C303 Q339 CR308



COMPONENT NUMBERS
300 SERIES

BOONTON ELECTRONICS CORPORATION

MODEL 92 SERIES
Schematic, Shaping Amp.
D830456L (Sheet 3 of 3)

WARRANTY

Boonton Electronics Corporation warrants its products to the original purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened or to any item which has been repaired or altered without our authorization.

We will repair, or at our option, replace any of our products which are found to be defective under the terms of this warranty.

There will be no charge for parts, labor, or forward and return shipment during the first three months of this warranty.

There will be no charge for parts, labor, or return shipment during the fourth through twelfth month of this warranty.

Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

BOONTON

BOONTON ELECTRONICS CORP. ■ RTE. 287 AT SMITH ROAD, PARSIPPANY, N.J. 07054 ■ (201) 887-5110

BOONTON

BOONTON ELECTRONICS CORP.
ROUTE 287 AT SMITH ROAD
PARSIPPANY, N.J. 07054 – U.S.A.
TEL: (201)887-5110
TWX: 710-986-8241